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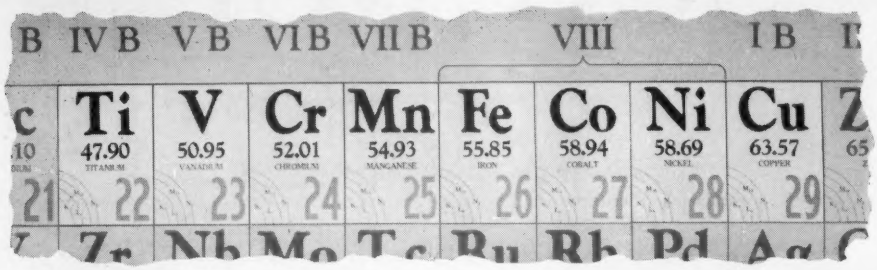

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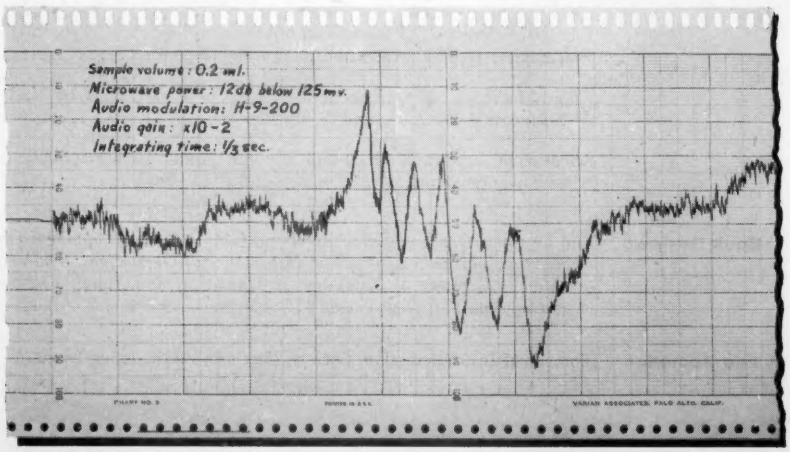

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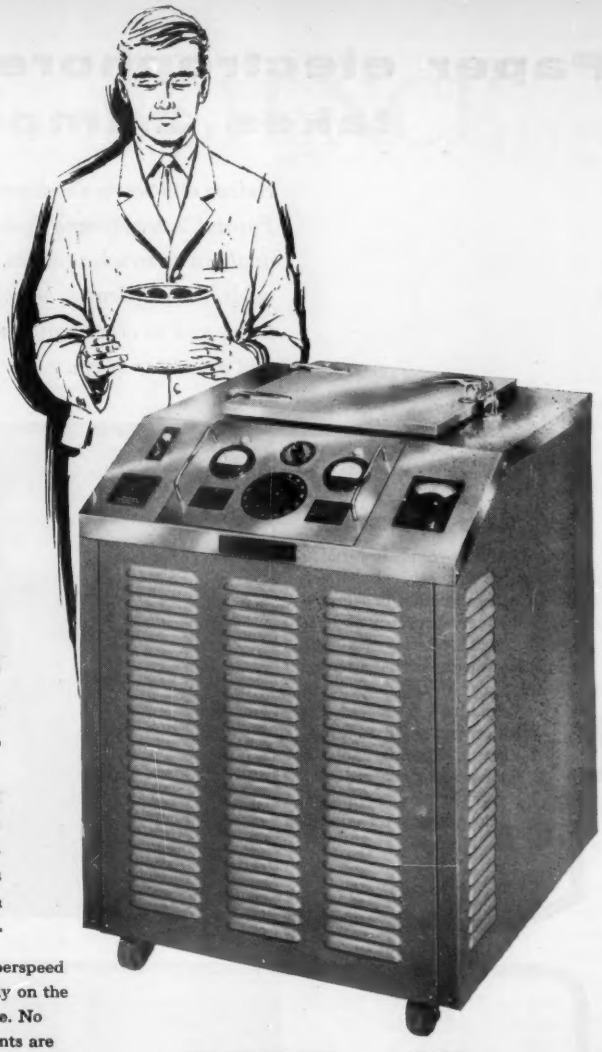

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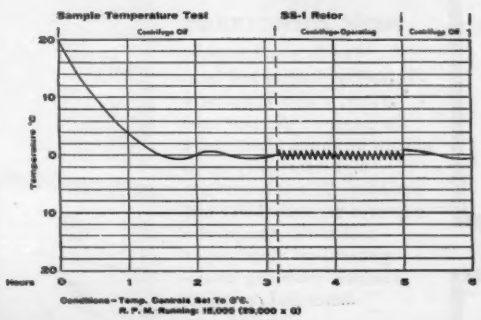

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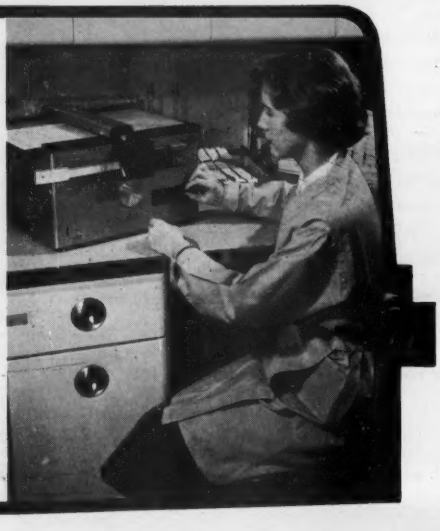

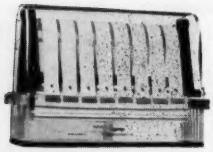

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Security

Few would disagree about the necessity for reform in our security system. The current arrangements present an image of chaos; no fewer than seven systems are in existence for civilian employees of the Government alone. It was recognition of these and other difficulties that led to the appointment of the Commission on Security nearly two years ago. The commission's report [abstracted in *Science* **125**, 114 (10 July 1957)] offers some valuable recommendations as well as some of doubtful merit.

Among the more valuable reforms are the recommendations for uniform security standards; the right of an employee to subpoena witnesses, to appeal rulings, and to confront and cross-examine accusers (unless they are Government informers, the disclosure of whose identity would diminish their usefulness), and the recognition that there may be a distinction between a person who is a security risk and one who is disloyal.

Some of the other recommendations have had considerable criticism in the press. There is some question about the wisdom of setting up a Central Security Agency to administer the entire program. Such an agency would inevitably acquire a good deal of power and would be difficult to control. In addition, the recommendation that it be a criminal offense for anyone to publish, knowingly or unknowingly, any material classified as secret or top secret is regarded by some as excessive and also as a limitation on the freedom of the press. In the latter connection the fear has been expressed that the classification of secret might be applied improperly and thus be used as an unwarranted means of censorship.

But there is a more important issue. This is the commission's proposal that security coverage be extended to *all* Government employees (except for those in the Central Intelligence Agency and the National Security Agency, who would be subject to more stringent requirements). This proposal runs counter to the stands taken in the statement by the Board of Directors of the AAAS [*Science* **120**, 957 (10 Dec. 1954)] and in the *Report of the Special Committee on the Federal Loyalty-Security Program of the Association of the Bar of the City of New York* (1956) as well as in a decision of the Supreme Court last year. The stand taken by all these bodies was that the present security system is broader than need be and that, in the words of the bar association, "positions are covered which have no relationship to national security" and that "clearance should be required for all sensitive positions and for no others." The AAAS board voiced a similar view and said, "No satisfactory justification has yet been advanced for screening persons engaged in unclassified research. . . ." The board also stressed the importance of taking a positive view of security questions and stated that the question should be *not* "How can we minimize our losses?" but "How can we maximize our gains?"

Ordinarily, it would be expected that Congress would consider these questions on their merits, hold hearings to permit the expression of different points of view, and, finally, prepare legislation to put all or part of the program into effect. To cast the security net more widely would certainly be expensive and would, in the opinion of a good many responsible people, do more harm than good to the security program. For Congress to act on security without the usual deliberation and without considering the whole program would be especially unfortunate. Yet precisely such a hasty and fragmentary approach is being advocated by the chairman of the commission, Loyd Wright, and by Representative Francis E. Walter. Walter has introduced, with Wright's backing, a "stop-gap" bill to blanket all federal employees into the security program at once. We trust that Congress will not be stampeded.—G. DuS.

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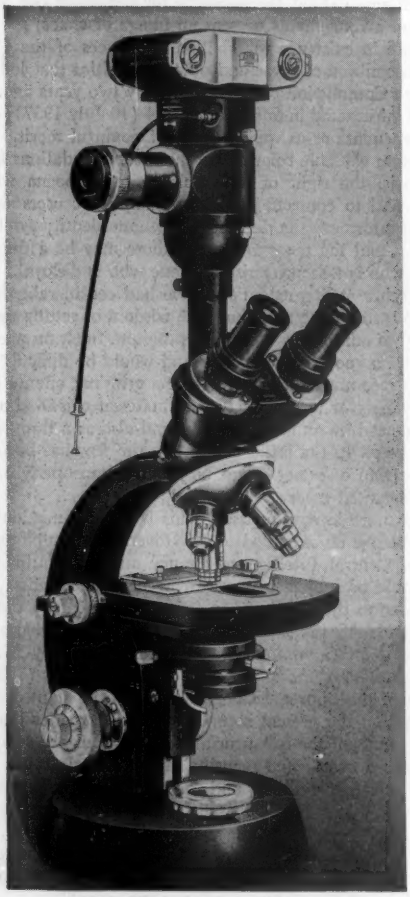

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Surface Properties of Semiconductors

Walter H. Brattain

Many of our most interesting and useful phenomena occur at surfaces, and I should like to start by emphasizing the importance of surfaces. We live, for example, on the surface of a planet. It is at a surface that the catalysis of chemical reactions occurs. It is essentially at a surface of a plant that sunlight is converted into a sugar. In electronics, most if not all active circuit elements involve nonequilibrium phenomena that occur at surfaces. Much of biology is concerned with reactions at surfaces.

If surfaces are so important, what do we know about them? What is a surface? What properties does a surface have that a physicist can measure? Of the various states of matter—solid, liquid and gaseous—physicists have long understood and explained the behavior of gases and are now, thanks to quantum mechanics, making considerable progress with simple homogeneous solids. Liquids are still quite obscure, and surfaces are still more so.

It was Irving Langmuir, a previous Nobel laureate, who gave us the first model of a surface—namely, clean tungsten in high vacuum—and who further explored some of the simple adsorption phenomena that take place at such a surface (*1*). The main physical measurement by which Langmuir could characterize his surface was the electronic work function or potential jump at the tungsten surface and the changes in this potential caused by adsorption of various foreign atoms or molecules. He could also measure heats of evaporation of these components. All this points up the following essential properties of a surface: (i) a surface is a boundary across which the concentration of one or more components changes greatly, and (ii) there is a potential jump or energy change associated with the surface. In the case of a metal, all these phenomena take place within a thickness of a few angstroms, making such a surface difficult to analyze. The behavior of a tungsten surface has for some time been a model for the understanding of all surface phenomena. But when some of the dirtier and often more interesting surfaces have been studied, it has been found that they have been too remote from clean tungsten for the latter to serve well in understanding their behavior.

Dr. Brattain is a member of the technical staff of Bell Telephone Laboratories, Murray Hill, N.J. This article is based on the lecture he gave before the Royal Swedish Academy of Sciences on 11 Dec. 1956 when he was awarded the Nobel prize in Physics for 1956, a prize that he shared with John Bardeen and William Shockley. It is published here with the permission of the Nobel Foundation. Dr. Bardeen's lecture appeared in the 19 July 1957 issue of *Science*.

Surfaces of Semiconductors

The main point of this story is that now, as a result of the progress that has been made in the understanding of semiconductors, we have another model of a surface, namely a p-n junction in a single crystal of a semiconductor such as silicon or germanium, and that this model is in a sense at the opposite extreme from clean tungsten. It can also be said that most surfaces lie in between these two models, and either model may be used for understanding the multitude of surface phenomena, whichever is best.

In particular, one can understand the complicated and dirty germanium gas surface at least qualitatively in terms of the p-n junction model. Let us first consider our p-n junction model. It occurs in one of the simplest, purest, and now best understood solids. For example, a single crystal of germanium, its atoms held together by well-understood covalent bonds, serves as a medium in which electrons and holes can exist in equilibrium. The existence of these components depends on the thermal dissociation of valence bonds, namely

$$(\text{valence bond}) \rightleftarrows n + p$$

The law governing this reaction is the mass action law

$$np = K, \qquad (1)$$

where n and p represent the concentration of electrons and holes in equilibrium at a given temperature. The constant K depends primarily on the absolute temperature T and the energy E_g necessary to dissociate a valence bond creating a hole-electron pair:

$$K \sim \exp -(E_g/kT) \qquad (2)$$

where k is Boltzmann's constant. The proportionality constant in Eq. 2 can be approximately derived from fundamental physical constants and the density of the crystal. The parameter characterizing the semiconductor is the energy E_g necessary to dissociate a hole-electron pair. It is approximately 0.75 electron volt for germanium and 1 electron volt for silicon, and it ranges in other semiconductors from a few tenths of an electron volt to several electron volts.

The main point here is that, although the product of the equilibrium concentrations is always a constant at a given temperature, the magnitude of either concentration can be varied over extreme ranges by solution of impurities in the semiconductor lattice. Substitutional solution of a fifth-column element in the lattice of silicon or germanium, as discussed by Shockley (*2*), makes n very large and p correspondingly small, the product remaining constant. Likewise, the solution in the lattice of a third-column element makes p large and n small.

Germanium Crystal

Consider now a p-n junction in a crystal of germanium, one side of which is n type ($n_1 > p_1$) and the other side p type ($p_2 > n_2$). At the contact between the two regions, we have the situation that n_1 must be greater than n_2 and, likewise, p_2 greater than p_1 since

$$n_1 p_1 = n_2 p_2 = K.$$

Because of this concentration difference, electrons will tend to diffuse from 1 to 2 and holes from 2 to 1. This will charge

region 1 positive and region 2 negative until an electric potential difference is built up just sufficient to make the field flow balance the diffusion flow. The crystal will then be in equilibrium. This potential is given by

$$V = (kT/e) \ln (n_2/n_1) = (kT/e) \ln (p_1/p_2) \quad (3)$$

Associated with this potential is a space-charge double layer at the boundary between the two regions. The charge density ρ is related to the potential by Poisson's equation

$$\frac{d^2V}{dx^2} = -4\pi\rho/\epsilon \quad (4)$$

where ϵ is the dielectric constant of the medium. The extent of this space-charge double layer is large compared with that in a metal. In germanium, it has a characteristic length of about 1×10^{-4} centimeter.

This is our model of a surface, a phase boundary across which the concentration of the components differs greatly, with the associated potential jump at the surface and the necessary charge double layer. Its properties can best be studied by changing the concentration of the components on each side of the surface from their equilibrium values. When one does this, one finds that the potential difference across the surface changes in a manner consistent with Eq. 3, and this change in potential can be measured. If p_1' and n_2' are the nonequilibrium concentrations of holes and electrons on sides 1 and 2, then the change in potential is given by

$$\Delta V = (kT/e) \ln (p_1'/p_1) = (kT/e) \ln (n_2'/n_2) \quad (5)$$

Note that it is the change in concentration of the minority carrier on each side of the boundary that is the controlling factor. Likewise, by changing from the equilibrium to the nonequilibrium state, one can measure the flow of charge into or out of the sample or the corresponding change in charge at the double layer.

By a consideration of rate processes going on at this interface, one can also write down a current-balance equation for this surface

$$I = I_s \left[\frac{p_1'}{p_1} - 1 \right] \quad (6)$$

where I_s is the saturation current and is determined by rates of recombination and thermal generation of electrons and holes on both sides of the surface. The nonequilibrium condition may be obtained by current across the surface, in which case I is this current, or by generation of electron-hole pairs in the neighborhood of the junction—for example, by light—in which case I is the rate of generation of pairs by light multiplied by the electron charge e. If both means are used, then I is the sum of both currents. Note that one can eliminate p_1'/p_1 from Eqs. 5 and 6, getting the well-known rectifier equation.

We see that the physical properties of this surface which can be measured are the changes in potential, changes in concentration occurring at the surface, and rates of return to equilibrium. These are in general the things one can measure for any surface.

Germanium Surface in a Gaseous Ambient

Let us now consider a germanium surface in a gaseous ambient. By the Kelvin method, one can measure a contact potential difference between the surface and a reference electrode. Any change in the potential jump at the surface will give a corresponding change in the contact potential. If the equilibrium at the surface is upset by shining light on the surface, the resulting potential change can be measured. This is the surface photo effect.

If the germanium is of the proper shape—thin and long—one can also measure the photoconductivity and from this deduce the change in minority carrier concentration for a given illumination. On a large sample of germanium, one can measure the lifetime of electrons and holes in the body of the germanium and then, from the transient behavior of the thin sample, the surface rate of recombination of holes and electrons.

As a result of all these studies, one finds that there is in general a space-charge double layer at the germanium surface. It is as if the germanium surface was of a given type, p or n, depending on the nature of the ambient gas, and as if the germanium interior must be in equilibrium with its surface. All the qualitative phenomena that one would find at a p-n junction, if one maintained, say, side 1 at a given fixed n-type and varied side 2 from p^+ to n^+, are found at a germanium gas interface. For example in the case of an $n - p^+$ junction the photo electromotive force is such as to make the n side more negative. As one changes the p^+ side from p^+ to just the same degree of n-ness as side 1, the photo electromotive force goes to zero, and when side 2 is made n^+ the photo electromotive force changes sign. This electromotive force is largest in magnitude for the $n - p^+$ case.

If side 1 had been p-type, similar changes would have occurred when side 2 was varied from p^+ to n^+, but now the photo electromotive force is largest for the $p - n^+$ case. This is also quite an accurate description of the germanium-gas surface. Moreover, the magnitude and sign of the photo effects at the extremes can be predicted if one knows the density of holes and electrons, the body lifetime, and the surface recombination for the sample in question. Furthermore, the experimental results agree with theory.

From the afore-mentioned results, one would predict that, since the surface of a germanium crystal in a gaseous ambient may be of a different type from the interior, the electric conductivity of the surface should be different from that of the interior, and, as the surface changes in type, this conductivity should change. In a thin enough sample, these changes can be measured.

Along with the changes in surface type, there must also be a change in the charge double layer. One can of course induce such a change in the charge double layer by applying an electric field perpendicular to the surface, and one can measure the change in conductivity induced by this field. This is the field effect which was predicted by Shockley but which at first could not be detected.

As a result of measurements of this change of conductivity with field and of the other changes at the surface with change in gaseous ambient, it is found that there are slow and fast changes at the surface. For example, if one illuminates the surface of germanium suddenly, the contact potential changes quickly to a new value, then slowly decays back toward the original value. The surface conductivity changes likewise, when one suddenly applies the field. There are, of course, changes in the charge double layer at the surface corresponding to the change in surface photo effect and surface conductivity.

From these results, one gets the concept of slow and fast states at the surface wherein this charge resides. The fast states are, so to speak, in good connection with the germanium body and can get into equilibrium or steady state with the body very quickly, in a microsecond or less. On the other hand, the slow states are poorly connected with the interior. It takes seconds or minutes for them to adjust to changes induced by light or field. These may not even be states at all but changes in adsorption equilibrium or steady state with the surrounding gas.

Potential Difference across Surface

The next step is that, from our knowledge of the properties of germanium, we can calculate, from the changes in conductivity, the potential difference across the space layer from the surface into the interior. We can also calculate the change in charge in the space-charge layer. As one changes the germanium surface from p^+ to n^+, the conductivity should go through a minimum. If, in an experi-

ment, one can find this minimum, one knows the potential difference across the space-charge layer and, from the change in conductivity from this minimum, one knows the change in this potential. Further, from the field-effect experiment, one can determine the total change in charge at the surface, and, from the change in conductivity, how much of this change in charge occurred in the space-charge layer.

The charge across the surface must of course add up to zero when there is no field at the surface. If Σ_b, Σ_f and Σ_s are the charges in the space-charge barrier layer, the fast states, and the slow states, respectively, then

$$\Sigma_b + \Sigma_f + \Sigma_s = 0$$

In the case of an applied field, the sum of these charges must be equal to the field-induced charge. By calculating Σ_b and measuring changes in total charge under slow and fast conditions, one can obtain values for both Σ_f and Σ_s. One can also determine the potential change across the space-charge layer and the total change in potential across the surface. For this type of surface, one has the chance of taking the surface apart and measuring the individual parts in some detail. What remains to be done is to determine at the same time the chemical changes that occur at this surface and to understand the relationship between the physical and chemical changes. When this has been accomplished—and I think it will be soon—the germanium surface will be the most thoroughly understood of all surfaces.

As an example of what already has been accomplished if one measures on the same surface at the same time certain quantities as a function of gas ambient, one can deduce the distribution in energy and capture cross-sections of the fast states or traps for electrons and holes. These quantities are the photoconductivity, the decay lifetime, the change of conductivity with field, and the surface photo effect. From these measurements and a knowledge of the body properties of the germanium sample, one can then deduce (i) the change of charge in the fast states with respect to the surface space-charge layer potential difference at zero added carrier concentration, (ii) the change of charge in the fast states with added carrier concentration at constant surface potential, and (iii) the surface recombination, all as a function of ambient gas or surface potential. These quantities all depend on the fast trap distribution in energy and on the surface potential. The second depends also on the ratio of the capture cross-section for holes and electrons, and the third depends as well on the product of the capture cross-sections. The relationships are integral equations and not easy to solve in general. One question is whether the trap distribution is discrete or continuous. An examination of all the pertinent data indicates that, at least for energies near the middle of the region between the valence and conduction bands, the distribution of traps in energy is continuous and is fixed and independent of gaseous ambient or germanium type for a given surface treatment. One can calculate approximately the ratio of the cross-sections, obtaining $6_p/6_n \cong 150$ and the product $6_p \times 6_n \cong 2.4 \times 10^{-31}$ cm^4, giving $6_p \cong 6 \times 10^{-15}$ cm^2, $6_n = 4 \times 10^{-17}$ cm^2. Not only are these values reasonable, but they suggest that the fast trap is acceptorlike—that is, that it is negatively charged when it is occupied by an electron and neutral when it is empty. The attraction between the hole and the negatively charged trap thus explains the larger cross-section for hole capture.

Conclusion

In conclusion, one can say that the physical nature of the germanium surface in a gas depends primarily on the surface treatment and the nature of the gas, and not on the type, p or n, of the body material. The reaction of the surface with the gaseous ambient, in particular the Bardeen-Brattain cycle of oxygen and water vapor, is an example of a low-grade catalytic reaction. The understanding of such a simple surface will ultimately contribute to understanding of other surface phenomena, especially catalysis. It was the original attempt to understand surface phenomena of this nature that led to the discovery of the transistor effect. Since then many people have contributed to the present understanding. Some of these are J. Bardeen and his group at the University of Illinois, H. K. Henisch and his group at the University of Reading, R. H. Kingston and his coworkers at Lincoln Laboratory, P. Aigrain and C. Dugas at the Ecole Normale in Paris, A. Many and his group at the Hebrew University, Israel, and my colleague C. G. B. Garrett. Equally important is the work of W. Brown on the field effect and, while not specifically dealt with here, his earlier work on channel conduction along with the similar work of H. Statz and his group at Raytheon.

References and Notes

1. I got my start working under J. A. Becker, who was one of the early contributors and who is still actively working in the field of metal surfaces. Let me say also that, while I am very proud to be one of the recipients of the Nobel award in physics, I am nevertheless well aware that I am only a representative of many others, without whose work and effort I would not have received the prize. May I mention first my teachers and in particular the late Prof. Benjamin H. Brown at Whitman College, who originally inspired me to take up physics and who also taught my mother and father. Then there are all the many workers in the field of semiconductors on whose shoulders we have stood. Finally, and more closely connected with our work, are all of our colleagues at Bell Telephone Laboratories whose efforts and cooperation made our work possible. In particular here I would like to mention R. S. Ohl, J. H. Scaff, and H. C. Theuerer, whose pioneering work on silicon made a new class of semiconductors available to physicists. It was Scaff and Theuerer who, as metallurgists, supplied the silicon and germanium with which we worked, and it was Ohl who first discovered a p-n junction in a melt of silicon prepared for him by the other two. One should indeed be very humble about accepting such an award when he thinks how fortunate he was to be in the right environment at the right time, to take advantage of all that had been done before. Let me here express my gratitude to all these people.
2. W. Shockley, Nobel lecture, 11 Dec. 1956.

Federal Support of Research in the Life Sciences

William V. Consolazio and Helen L. Jeffrey

In a recent article in *Science* (*1*), summary data were presented on the nature and the size of federal grant and contract activities in the life sciences for 1952 and 1954. The National Science Foundation has now published a study for fiscal year 1955 (*2*).

Summary data are here presented (*3*) for the three years' studies in order to point out the trends which have developed in this component of the federal research program during the period for which information is available.

Total Federal Support to Science

In fiscal year 1955, the federal research and development program totaled $2291 million (*4*). Of this, $206 million, or 9 percent, represented the life-sciences component; $82.5 million (Table 1) or 4 percent of the total research and development program, or 40 percent of the total life-sciences component, was earmarked for grant and contract activities. The $82.5 million represents a growth of 28 percent over the $64.5 million of fiscal year 1954 and of 77 percent over the $46.6 million of calendar year 1952. The number of projects grew from 6400 in calendar year 1952 to 8100 in fiscal year 1954, and to 9500 in fiscal year 1955. Two thousand grants and contracts were terminated between the fiscal years 1954 and 1955, totaling $14.6 million; 3300 were activated, totaling $32.0 million. This change does not necessarily reflect a true turnover. Agencies of the Federal Government which have grant authority award grants for varying periods of time, up to 5 years. At the termination of the grant period, the project under way may be reconsidered for continued support.

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Distribution by Agency

The data for the distribution of federal contract and grant funds in the life sciences, by agency, for the years 1952, 1954, and 1955 are reported in Fig. 1. Agencies such as the Office of Naval Research and the Army research groups have shown little growth for the years reported. All others have shown a fairly substantial percentage increase, especially between 1954 and 1955. In terms of relative growth, the National Science Foundation showed the greatest increase for the years reported, practically doubling its support each succeeding year. The agencies that show the greatest absolute growth for the last 2 years reported are the Department of Agriculture ($4 million) and the National Institutes of Health of the Department of Health, Education, and Welfare ($8 million). The total increase for all federal agencies for this period was $18 million; $12 million, or 66 percent, of this total increase was attributable to the activities of these two agencies.

Support to the life sciences in 1955 came, to a large degree, from the "special mission"-oriented agencies of the Federal Government. Support by the defense-oriented agencies (Atomic Energy Commission, Army, Navy, and Air Force) increased from $20.7 million, in fiscal year 1954, to $24.1 million, in fiscal year 1955; that by the agriculture-

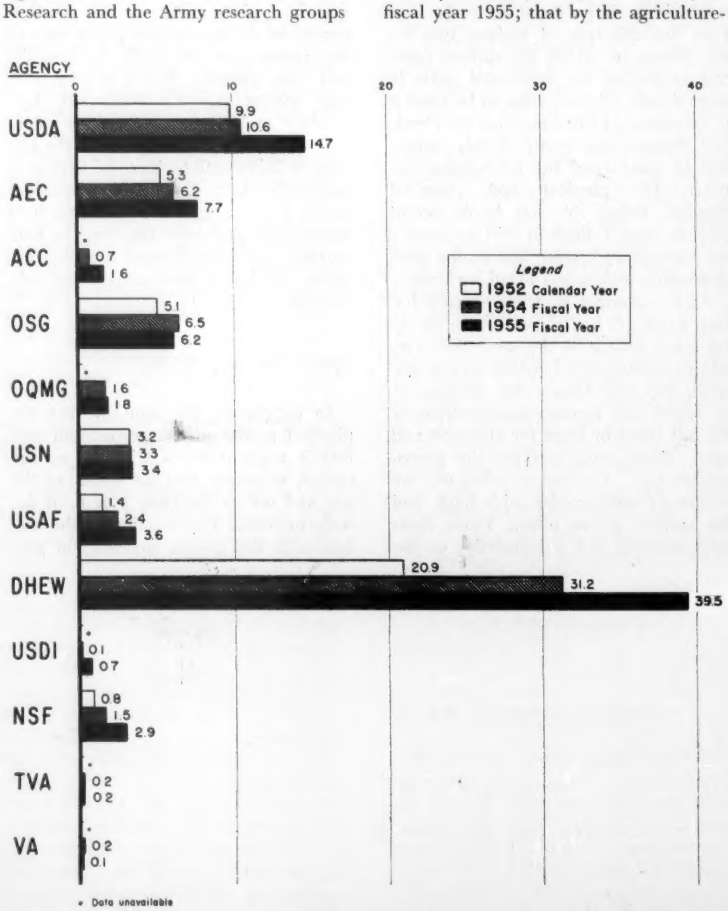

Fig. 1. Annual rate of support in millions of dollars, by agencies, for federal grants and contracts for unclassified research in the life sciences for 1952, 1954, and 1955.

Table 1. Number and annual rate of federal grants and contracts for unclassified research in the life sciences by years.

Period	No. of projects	Annual rate (thousands of dollars)
Calendar 1952	6400	46,628.0
Fiscal 1954	8144	64,532.9
Fiscal 1955	9496	82,544.0

oriented agencies (Department of Agriculture and Tennessee Valley Authority) increased from $10.8 million to $14.9 million; and that by the health-oriented agencies (Department of Health, Education and Welfare and Veterans Administration) increased from $31.2 to $39.5 million. The absolute dollar increase for these "special mission"-oriented agencies between the fiscal years 1954 and 1955 was $16.6 million out of the total increase of $18.0 million.

Table 2. Distribution, by broad classification, of support for federal grants and contracts for unclassified research in the life sciences for 1952, 1954, and 1955.

Item	Calendar 1952		Fiscal 1954		Fiscal 1955	
	Annual rate (thousands of dollars)	Percentage of total funds	Annual rate (thousands of dollars)	Percentage of total funds	Annual rate (thousands of dollars)	Percentage of total funds
Basic biological science	18,356.0	39.4	26,291.8	40.7	30,330.6	36.7
Applied medical science	16,117.0	34.6	23,721.5	36.7	25,081.7	30.4
Applied agricultural science	7,646.0	16.4	8,126.5	12.6	11,440.1	13.9
General support of science	4,509.0	9.7	6,393.1	9.9	15,691.6	19.0*
Total	46,628.0	100.1	64,532.9	99.9	82,544.0	100.0

* Includes $6.5 million for "Training," most of which was in health sciences.

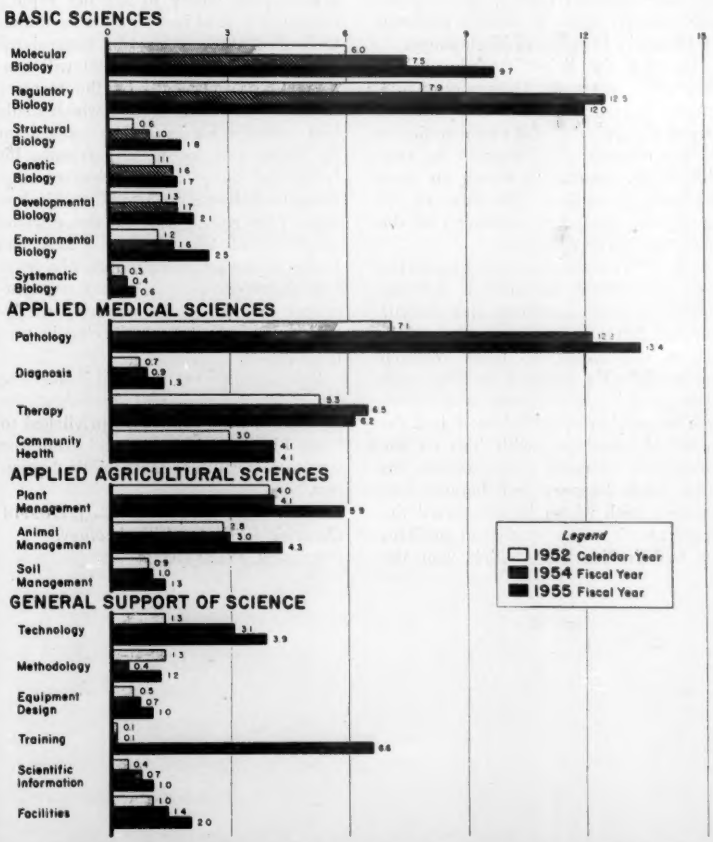

Fig. 2. Annual rate of support in millions of dollars, by category, for federal grants and contracts for unclassified research in the life sciences for 1952, 1954, and 1955.

Distribution by Category

The data for the distribution of federal grant and contract funds in the life sciences, by category (*1*), are presented in Fig. 2. All categories with the exception of "Methodology," "Regulatory biology," "Therapy," and "Community health" show a progressive increase since 1952. The fall-off in "Methodology" in 1954 may represent an artifact, reflecting a redefinition for this category in that year. The decrease in funds available to "Regulatory biology" and "Therapy" between 1954 and 1955 primarily reflects a reduction in programing in these categories by the National Institutes of Health.

The sizable increase for "Training" which appeared between 1954 and 1955 actually occurred in 1954, although considerable growth had already occurred prior to that time but was not reported (*2*). The majority of the funds in this category came from the National Institutes of Health.

Summary

Federal support of contract and grant research in the life sciences continued to grow during the period 1952–55 and showed an increase of 28 percent between the years 1954 and 1955. The basic biological science component (Table 2) increased from $18 to $26 million between 1952 and 1954 and to $30 million in 1955. Although a greater dollar amount is now available for basic research in the life sciences, the amount available in 1955 was proportionately a smaller part of the total than was the amount available in 1954. In 1955, $52 million was expended for activities which were not categorized as basic research. The needs and motivations of the major granting federal agencies are, and continue to be, primarily problem- and program-oriented.

References and Notes

1. W. V. Consolazio and M. C. Green, *Science* 124, 522 (1956).
2. National Science Foundation, *Federal Grants and Contracts for Unclassified Research in the Life Sciences, Fiscal Year 1955* (NSF, Washington, D.C., 1956).
3. The data presented in this article are from official findings of the National Science Foundation. However, the conclusions, whether stated or implied, are those of the authors and do not necessarily reflect the views of the National Science Foundation.
4. National Science Foundation, *Federal Funds for Science V: The Federal Research and Development Budget, Fiscal Years 1955, 1956, and 1957* (NSF, Washington, D.C., 1956).

A. C. Schaeffer, Mathematician

In 1949, the coveted Bocher prize for outstanding achievement in mathematics was awarded to Albert Charles Schaeffer and Donald C. Spencer. I happened to visit Schaeffer the day after he received the good news. His intense pleasure and complete surprise at being thus recognized showed the modesty with which he looked on his own achievements. On 2 February 1957, by the sudden death of Albert Schaeffer, American mathematics lost one of its most original minds and one of its most interested and interesting contributors.

Schaeffer's marks of distinction were his tenacity and his overwhelming desire to throw all his intense energy into solving stubborn mathematical problems. Where others turned aside and were content to seek closer goals, he continued, overcoming obstacles with originality and technical brilliance and always emerging with a contribution worthy of his extremely high standards. He wanted none of the credit for arriving at insignificant mathematical formulas; rather, his expert attention was all directed toward hard analysis, and it was here that he attained his reputation.

Schaeffer did not discover his interest in mathematics until he was a practicing engineer with the State Highway Commission of Wisconsin. He held a degree in civil engineering from the University of Wisconsin and had married the former Carol Marsh of Boston. In 1933, after he found that even the smallest mathematical problem that arose in connection with his work was of compelling interest to him, he resigned his position with the State Highway Commission and entered the graduate school of Massachusetts Institute of Technology, in the field of applied mathematics. Encouraged by his loyal wife, he went on to receive the Ph.D. degree, in 1936. He never returned to engineering, although his interest in its problems was always evident.

The beginning of Schaeffer's active and productive career as teacher and scholar showed again his drive and tenacity. Teaching positions were scarce in 1936, but he did not sit back and wait for offers. Instead, he drove from college to college, diploma in hand, asking about possible openings. His first opportunity came with the offer of a position as instructor at Purdue University. Later he moved to Stanford, then back to Purdue, where he remained until 1950, except for one semester spent as visiting professor at Carnegie Institute of Technology.

In 1950 the Schaeffers returned to their alma mater, the University of Wisconsin. Schaeffer was now recognized as one of the truly forceful mathematicians of the country. At Wisconsin he continued his vigorous research in pure mathematics and, at the time of his death, was serving as chairman of the mathematics department.

Schaeffer's research interests lay in the area of analysis—polynomials, schlicht functions, entire functions, and analytic number theory mark the general subdivisions into which his many research papers fall. He enjoyed working with others, and it was a pleasure and a privilege to collaborate with him. I had the honor of associating with him on the production of many early papers. His other most frequent collaborator was Spencer, with whom he completed the major attack on the coefficient problem for schlicht functions which won the Bocher prize and which was published as a colloquium volume by the American Mathematical Society in 1950.

Schaeffer's work in mathematics had many facets. He was an active member of the Mathematical Association of America and of the American Mathematical Society and served a term as associate secretary of the latter. During World War II he was active on several research panels and later was director of the Office of Naval Research Mathematics Project at Stanford, working in close association with George Polya, Gabor Szegö, Spencer, and others. More recently he had served as editor of the *Proceedings of the American Mathematical Society* and of the *Duke Journal* and as a consultant on various national panels and committees.

The students who came under Schaeffer's influence will never forget his intense interest in his subject and in teaching, his capacity for hammering together, before their eyes, the precise, complicated structure he wished to present. Those who worked more closely with him on research will always recall with admiration his utter disregard of stumbling blocks in the way of mathematical progress, his ability to advance rapidly along any line of investigation he undertook. And those of us who appreciated him most and loved him best will continue to be influenced by the memory of those traits of character which made him unique—his boundless enthusiasm for living and for making friends, his frank and outspoken criticism of anything he believed to be unjust, his loyalty to his colleagues, and the extreme simplicity of his nature. To him, the poetry expressed by the motion of a baseball player was as exquisite as any symphonic movement. He was without deceit and was completely lacking in pretentiousness.

Science could use many Al Schaeffers; his influence will be felt throughout the lifetime of those who were privileged to know him, and his work will point the way to much future mathematical progress.

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News of Science

Element 102

A joint research effort by scientists from the United States, Great Britain, and Sweden has led to the discovery of element 102. The international research team included investigators from the chemistry division of the U.S. Atomic Energy Commission's Argonne National Laboratory at Lemont, Ill., the chemistry division of the United Kingdom's Atomic Energy Research Establishment at Harwell, and the Nobel Institute for Physics in Stockholm, Sweden.

The new element was produced by bombarding curium, which is element 96, with carbon ions accelerated in the cyclotron at the Nobel Institute. The scientists who took part in the experiment, the first to lead to the discovery of an artificially created element by an international research team, are as follows:

From Argonne, Paul R. Fields, a group leader in the chemistry division, and Arnold M. Friedman, who is working at Harwell for 1 year under an exchange of U.S. and British nuclear scientists;

From Harwell, John Milsted, a chemist who last year conducted research at Argonne under the U.S.-U.K. exchange program and helped separate the curium used in the bombardments; and Alan Beadle, a chemist;

From the Nobel Institute for Physics, Hugo Atterling, physicist; Wilhelm Forsling and Lennart Holm, chemists; and Bjorne Astrom, physicist.

The United States, through the Argonne National Laboratory, provided the very rare isotopes of curium used in the experiments. The curium was shipped to Harwell, where Friedman, Milsted, and Beadle prepared the targets for the experiments. Harwell provided a rare isotope of carbon, carbon-13, which was used as the bombarding particle. The Nobel Institute provided the cyclotron, some special equipment, and a staff of physicists, chemists, and technicians. The cooperation with Nobel Institute was started because the cyclotron at the institute could provide the intense source of high-energy carbon-13 ions that were necessary for the experiment.

The three-nation group began experiments in the cyclotron in March. First indications that the new element had been discovered were found a few days later. The group performed another series of experiments in April which confirmed the original findings. Similar experiments have just been concluded confirming again the original discovery. This isotope of element 102, thought to have an atomic mass number of 253, is very unstable, having a half-life of 10 to 12 minutes and emitting alpha particles.

Lysenko in Favor?

Trofim D. Lysenko, controversial Soviet geneticist, is apparently again to hold a significant place in Soviet science. This is indicated by the fact that on 17 July an extensive interview with Lysenko was given a prominent position in *Pravda,* leading newspaper in the U.S.S.R. The report indicated that Lysenko had been asked by the current regime to aid his country's program to increase per capita production of meat, milk, and butter. In the *Pravda* interview, which dealt particularly with milk production, Lysenko again put forward his now almost historic anti-Mendelian thesis that acquired characteristics can be inherited.

After pointing out that large calves are a serious problem to the dairy industry, he presented his solution. Cows of high milk productivity should be bred to bulls of a smaller strain such as Jerseys, that are noted for providing high butter-fat content. By feeding an especially enriched diet during gestation, he claimed that it would be possible to produce calves which would grow to a smaller size when mature, but which would give an increased quantity of milk. Lysenko maintained that these desirable characteristics would be inherited.

During the Stalin era, Lysenko was a dominant figure. He became head of the Academy of Agricultural Sciences in 1938, a post from which he was forced to resign in 1956. After Stalin's death many of Lysenko's scientific opponents regained their positions. Some of them openly criticized him, and several Soviet journals carried articles disputing his theories of stimulating changes in plant life that then would become hereditary.

Universities in Turkey and Vietnam

Two new universities are to be set up shortly in Turkey and Vietnam. Ataturk University, to be established at Erzerum in the eastern part of Turkey, will be the country's fifth university. It will specialize chiefly in the teaching of the agricultural sciences, but will also have faculties of law, economics, and medicine.

In Vietnam, the country's ancient capital, Hue, has been chosen as the site of the new university, which will open at the beginning of the next academic year. Courses will include philosophy, modern languages, law, pedagogy, physics, chemistry, and biology.

Shark Fossil

The Chicago Museum of Natural History has announced discovery of a fossil shark that is 250 million years old. The museum reports that the fossil was found in shale formations in Parke County, Ind., several weeks ago by Rainer Zangerl and Eugene S. Richardson, Jr.

This is believed to be the first well-preserved shark fossil ever found from the Carboniferous period. The remains of the shark measure 8½ feet in length, and it is estimated that they would have been about 15 feet long had they been complete. Because sharks have cartilagenous skeletons, they are rarely preserved as fossils.

News Briefs

The *Effects of Nuclear Weapons,* a 579-page handbook that provides latest knowledge of weapons effects, has been published by the U.S. Atomic Energy Commission. It is on sale for $2 a copy by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

* * *

Electronic Associates, Inc., Long Branch, N.J., has announced the opening of its European Computation Center in Brussels, Belgium. This center is one of the first commercial facilities of its kind to be placed at the service of European industry and technological research.

* * *

Two century-old firms, W. R. Grace and Company of New York and Pechiney, French chemical and metallurgical concern, have announced the formation of a new company in the United States to produce high-purity elemental silicon and other semiconductors. Location of the plant has not yet been made public, but it is expected to be in operation within a year.

Singer Acquitted

The U.S. Court of Appeals has reversed itself and ordered acquittal of Marcus Singer, professor of zoology at Cornell University who had been convicted of contempt of Congress. In 1953 Singer told the House Committee on Un-American Activities that he had once been a Communist, but he refused to name others with whom he had been associated in Communist activities. He was indicted in 1954 and since that time has been suspended from teaching duties, although receiving full salary.

He has continued his research in the fields of growth and regeneration, work supported in part by the American Cancer Society. After the court decision was announced, Provost Sanford S. Atwood of Cornell told the press that the legal proceedings had "produced no evidence of Prof. Singer's unfitness to teach and he is being reinstated as a teaching member of the faculty."

Asian Nuclear Center

Representatives of 16 nations met in Washington this month to work on the organizational and financial structure of an Asian nuclear center to be established at Manila. The United States has offered $20 million to equip the center and pay initial operating costs.

The United States invited the members of the Consultative Committee of the Colombo Plan to Washington for the following purposes: to decide finally whether they wish to go ahead with the idea of establishing the center; to see for themselves at the Brookhaven National Laboratory, Upton, N.Y., the kind of institution toward which they would be working; to set up a plan for the organization and future financing of the center.

The Colombo Plan Committee consists of representatives of all the non-Communist Asian nations from Pakistan to Japan, except South Korea and Nationalist China, plus contributing members—Australia, Britain, Canada, New Zealand, and the United States. Together these countries form a loose organization for mutual assistance. Robert McClintock, chairman of the U.S. delegation, was elected permanent chairman of the meeting.

Europeans Tour Nuclear Power Facilities

A group of 50 industrialists and government officials from Belgium, France, West Germany, Italy, Luxembourg, and the Netherlands toured various installations of the U.S. Atomic Energy Commission and the plants of several private companies during July. The purpose of the tour, which was sponsored by the AEC, was to provide the visitors with firsthand knowledge of the technology associated with setting up large power reactor complexes.

Since the primary interest of the visitors was in reactors that can be built in Europe at an early date, their itinerary took them to facilities actually engaged in various phases of work on the pressurized and boiling-water reactor systems. Included were commission sites where pressurized and boiling-water reactors have been designed, constructed, and operated, and plants engaged in fuel-element fabrication, manufacture of pressure vessels and other components, and chemical processing.

The governments of the six countries represented in the group signed in Rome on 25 Mar. the treaty which, when ratified, will establish the European Community for Atomic Energy, known as EURATOM. The purpose of EURATOM is to contribute to the formation and the rapid growth of a European nuclear industry. Early this year three representatives of these countries surveyed the nuclear power programs of the United States, Canada, and the United Kingdom and in May issued a report, *A Target for EURATOM,* that recommends a goal of 15 million kilowatts of installed nuclear electric capacity by the end of 1967. The report stated that to meet the goal it would be necessary to begin with reactor systems that are the most advanced technologically.

New High-Strength Steel

The National Bureau of Standards has experimentally produced steel that can be heat-treated to a strength of 285,000 pounds per inch with sufficient ductility for structural applications. Developed by Samuel J. Rosenberg and Carolyn R. Irish of the bureau's thermal metallurgy laboratory, the steel is made by normal melting and working processes and should not be difficult to manufacture.

In recent years the increasing demand for reduced weight in aircraft structures has been a constant stimulus for the development of high-strength steels. One of the principal applications for such materials is in aircraft landing gears. Because landing gears constitute approximately 10 percent of the weight of an empty military plane, the use of an ultra-high-strength steel in such components can save considerable dead weight. Because of the urgent need for stronger steels in this particular application, the Navy Bureau of Aeronautics has sponsored an investigation at NBS to develop a steel having a tensile strength of approximately 300,000 pounds per inch.

Although many steels can be heat-treated to strengths of 300,000 pounds per inch and higher, they are normally quite brittle at this strength level. Such brittleness prohibits their use in structural applications where a certain amount of ductility and toughness is required. The present investigation therefore concentrated on developing a steel that would not only be strong but would also have high impact resistance.

New Missing Link Discovered

To zoologists the recently reported discovery by the Galathea Expedition of the extraordinary deep-sea mollusk *Neopilina galatheae* [H. Lemche, *Nature* (23 Feb. 1957)] will seem even more incredible than the famous discovery in recent times of *Latimeria,* the living coelacanth, even though the layman may see less of interest in the mollusk than in the fish. *Latimeria,* however, represents a group of fishes which survived into the Cretaceous period, and became extinct only some 70 to 90 million years ago; whereas the new-found mollusk represents a class that existed in the Cambrian to Devonian periods of the Paleozoic, and was supposed to have become extinct about 280 million years ago, when the coelacanths were just beginning to branch off as a special side-group of the other lobe-finned fishes (crossopterygians). *Latimeria,* moreover, seems to be a conventional sort of coelacanth, except for its salt-water habitat; but *Neopilina* is an obviously *segmented* mollusk, violating one of the general criteria by which mollusks are most readily known, their unsegmented body plan. *Neopilina,* of which 10 specimens and 3 additional shells were dredged up from a depth of 3590 meters off the west Mexican coast on 6 May 1952, has a fragile shell somewhat resembling that of a limpet, but there the similarity to any gastropod ends. The fossils of the class had already given evidence of symmetrically arranged pairs of shell muscles. The living animal exhibits segmentation in other significant features as well. There are five pairs of auricles that receive blood from the gills, one pair of auricles for each of the pairs of comblike gills (ctenidia). There are also paired excretory organs, nephridia, again one pair for each of the five segments of the mollusk's body. There may be other internal organs which are segmented in arrangement, but further study of the internal anatomy will be required to clarify such matters.

Neopilina represents a primitive form of mollusk intermediate between the amphineurans (chitons) and the cephalopods, but best placed, according to Lemche, in a distinct class, the Mono-

placophora. Some of its fossil relatives which have even higher numbers of paired muscle scars on the inside of the shell may well have been the connecting links between the mollusks and the typically segmented annelid worms and arthropods.—BENTLEY GLASS

Carnegie Petroleum Laboratory

The Chemical and Petroleum Research Laboratory was incorporated at Carnegie Institute of Technology on 14 July. The new facility is composed of three chemical research units: the Petroleum Research Laboratory, the Manufacturing Chemists Association Research Project, and the Thermochemical Laboratory.

The incorporation was made in order to make it possible to carry on, within one administrative organization, a number of related continuing research projects of a permanent character. The new laboratory is affiliated with the department of chemistry and will be under the direction of Frederick D. Rossini, head of the department of chemistry. Beveridge J. Mair is assistant director.

IGY Bulletin

The first issue of the *IGY Bulletin*, a new publication of the U.S. National Committee for the International Geophysical Year, was released this month. Reprints of the *Bulletin* will be distributed monthly to scientists and others directly concerned with the IGY program. (In alternate months, two issues will be published in the bimonthly *Transactions of the American Geophysical Union.*)

The first number of the *Bulletin* reports on some major aspects of the IGY program as it stands at the beginning of the Year. Similar treatment will be given the remaining program areas in the next few issues, thereby establishing a base for the reporting of IGY events, activities, and findings as the Year progresses.

U.N. on Natural Energy Sources

New ways in which man can conserve the earth's dwindling fuel supplies by harnessing certain natural forces now chiefly wasted are described in a report released recently by the United Nations. The report, to be considered by the Economic and Social Council this summer, was written to meet a request by the council last year for studies on the practical use of five new sources of energy: solar energy, wind energy, geothermic energy, tidal energy, and thermal energy of the seas. As called for by the council resolution, it pays special attention to the possibilities of raising the living standards and economic development of less developed countries.

In preparing this report, the secretariat had the help of five specialists who wrote background studies on each of the new energy sources. They were: on solar energy, Farrington Daniels, chairman of the chemistry department of the University of Wisconsin; on wind power, E. W. Golding, Electrical Research Association, London; on tidal energy, Robert Gibrat, professor of industrial power, Ecole Nationale Superieure des Mines, Paris; on geothermic energy, Ing. Remo Alessandri, Director General of the Societa Larderello, Florence; and on thermal energy of the seas, Christian Beau, inspector general of bridges and highways, Energie des Mers, Paris.

The new U.N. report is the first section of what will eventually be a three-part printed volume. It describes in a general way the five natural energy sources, reviews briefly methods which have been devised to use them for economic purposes, and evaluates their main features. Next, it examines the role which each energy source may play in the production of electric power as well as its nonelectrical applications. Finally, lines of action are suggested for developments which seem to be more important than others. The second and third parts of the report will consist of extracts from the technical background studies of the specialists and a comprehensive annotated bibliography prepared by the U.N. Educational, Scientific and Cultural Organization.

Ultrastructure Research

Academic Press Inc. has announced publication of the *Journal of Ultrastructure Research*, which is to be edited by Fritiof S. Sjöstrand and Arne Engström, both associated with the Karolinska Institutet, Stockholm, Sweden. The purpose of the new journal is to assemble in one medium papers dealing with the ultrastructure of the elementary structural as well as functional components of cells and tissues. Papers on biological material analyzed by means of electron microscopy, x-ray diffraction techniques, x-ray microscopy, polarization optical analysis, and polarized infrared analysis will be acceptable, as will those describing techniques and instruments of importance for the development of ultrastructure research.

The editorial board will consist of F. B. Bang (U.S.A.), W. Bernhard (France), A. Claude (Belgium), V. E. Cosslett (England), Albert J. Dalton (U.S.A.), John Farrant (Australia), A. Frey-Wyssling (Switzerland), Alan J. Hodge (Australia), Daniel C. Pease (U.S.A.), J. B. Le Poole (Netherlands), J. T. Randall (England), Ernst Ruska (Germany), W. J. Schmidt (Germany), Hugo Theorell (Sweden), Arne Tiselius (Sweden), and R. W. G. Wyckoff (U.S.A.).

The first volume, priced at $15, will have four issues. Manuscripts by Ebba Andersson, A. J. Dalton, R. Ekholm, E. Fauré-Fremiet, D. Ferreira, A. Frey-Wyssling, B. Vincent Hall, E. L. Kuff, M. G. Menefee, and C. Rouiller have been accepted for publication in the initial issues. Manuscripts and queries concerning details of editorial policy and rules regarding the preparation of papers should be sent to the Editorial Office, Journal of Ultrastructure Research, Department of Anatomy (Karolinska Institutet, Stockholm 60, Sweden. Subscription orders should be sent to the publishers, Academic Press Inc., 111 Fifth Ave., New York 3, N.Y.

IT&T Standards Laboratory

A new standards laboratory for testing and certifying master mechanical and electrical measuring devices was opened recently at Clifton, N.J., by International Telephone and Telegraph Corporation. The dedication ceremonies featured an address by Allen V. Astin, director of the National Bureau of Standards.

To be known as the IT&T Standards Laboratory, the new facility is located within the IT&T Federal Telephone and Radio Company division's factory building, and within a short distance of Federal Telecommunication Laboratories, IT&T's research division. One of the best equipped privately owned installations of its kind, it is designed to provide a convenient service in the field of mechanical and electrical measurements, supplementing and extending that of the National Bureau of Standards, to private companies, to organizations such as universities and scientific foundations, to U. S. government agencies, and to IT&T system companies throughout the world.

IAEA Preparatory Commission

The Preparatory Commission of the International Atomic Energy Agency, composed of representatives of 18 countries, has completed its sixth session at United Nations Headquarters in New York under the presidency of Carlos A. Bernardes (Brazil) and with Pavel Winkler (Czechoslovakia) as its vice president. The commission reached unanimous agreement on a recommendation for a program of activities of the agency for its initial year as well as on the budget, staff establishment, and financing required to carry out this program. The

report will be published as soon as it has been communicated to the governments of the 80 states that signed the IAEA statute. A number of documents on administrative and procedural matters were also approved by the commission.

Furthermore, a draft relationship agreement with the United Nations was prepared and negotiated with the United Nations Advisory Committee on the Peaceful Uses of Atomic Energy. This agreement will now be submitted for approval to the general conference of the agency and to the United Nations General Assembly.

During July the Preparatory Commission secretariat has been transferring to Vienna, where the executive secretary, Paul R. Jolles, will assume responsibility for organizing the first general conference, scheduled to open in Vienna on 1 Oct. All countries that have signed the statute and have deposited instruments of ratification by that time will participate in this conference as initial members of the agency.

Yale Medical School Expands

Yale University has awarded a contract for an extension to the Sterling Hall of Medicine. The new four-story building will provide additional facilities for the departments of anatomy and biochemistry. Construction will begin this summer and the laboratory is expected to be ready for occupancy by September 1958. The cost of the project is $1 million, half of which will be derived from a grant under the Federal Health Research Facilities Construction Program.

Proposed Legislation

Of the many bills introduced in Congress, some have a special relevance to science and education. A list of such bills introduced recently follows:

S 2408. Authorize a special milk program, a veterans and Armed Forces dairy-products program, and an accelerated brucellosis eradication program. Thye (R Minn.), Wiley (R Wis.) Senate Agriculture and Forestry.

H Res 304. Provide for consideration of HR 6814, a bill to provide for compulsory inspection by U.S. Department of Agriculture of poultry and poultry products. Trimble (D Ark.) House Agriculture.

S 2409. Establish a Federal Recreation Service in Department of Health, Education and Welfare. Neuberger (D Ore.) Senate Labor and Public Welfare.

HR 8390. Protect the public health by amending Federal Food, Drug, and Cosmetic Act to prohibit use in food of additives which have not been adequately tested to establish their safety. Harris (D Ark.) House Interstate and Foreign Commerce.

S 2415. Prescribe a standard of loyalty to the U.S. Government for military personnel to prescribe procedure for determination of the loyalty of such personnel. Cotton (R N.H.), Stennis (D Miss.) Senate Armed Services.

S 2399. Establish a Central Security Office to coordinate administration of federal personnel loyalty and security programs, to prescribe administrative procedure for hearing and review of cases arising under such programs. Johnston (D S.C.) Senate Post Office and Civil Service.

S 2375. Provide a program for development of minerals resources of U.S., its territories, and possessions by encouraging exploration for minerals and providing for payments as incentives for production of certain minerals. Watkins (R Utah), Bennett (R Utah) Senate Interior and Insular Affairs.

S 2395. Establish methods of lessening nation's dependence on foreign sources of lead and zinc in times of emergency and promote general economy of nation. Murray (D Mont.), Mansfield (D Mont.) Senate Interior and Insular Affairs.

HR 8366. Establish beneficial development of forest resources of Indian lands as policy of Congress. Metcalf (D Mont.) Senate Interior and Insular Affairs.

Scientists in the News

FRITZ A. LIPMANN, professor of biological chemistry at Harvard Medical School and head of the biochemistry research laboratory at Massachusetts General Hospital, will move on 1 Sept. to the Rockefeller Institute in New York, where he has been named a member and professor. He will take several members of his staff with him and will conduct research in new laboratories now being completed at the institute. Lipmann received the Nobel prize for medicine and physiology in 1953 for the discovery of coenzyme A.

MICHAEL T. CRONIN, formerly associate pathologist at Penrose Research Laboratories, Philadelphia, Pa., and assistant professor of veterinary pathology at the University of Pennsylvania, has been named manager of the newly formed department of toxicology and pathology in the research laboratories of Schering Corporation, Bloomfield, N.J.

L. W. MILLER, professor of biological science at Illinois State Normal University, has been appointed chairman of the division of natural science at Chico State College, Chico, Calif.

ARTHUR L. SCHIPPER, who has been in the department of biology at the University of Notre Dame since 1948, is the new assistant in the University Relations Division of the Oak Ridge Institute of Nuclear Studies.

Rear Admiral R. S. HATCHER, USN (ret.), recently joined the Aerojet-General Corporation, Azusa, Calif., to work in the field of advanced planning. Hatcher, who was assistant chief of research and development in the Navy's Bureau of Aeronautics at the time of his retirement in 1955, has for the last 2 years been affiliated with the Guggenheim School of Aeronautics at New York University.

This year's honorary degree recipients include the following:

GILBERT DALLDORF of the division of laboratories and research, New York State Department of Public Health, from the University of Freiburg, Germany.

WILLIAM R. EHRICH, professor in the University of Pennsylvania Graduate School of Medicine, from the University of Freiburg, Germany.

MARION S. FAY, dean of the Woman's Medical College of Pennsylvania, from Beaver College.

MERVIN J. KELLY, president of Bell Telephone Laboratories, from the University of Pittsburgh.

OTTO KRAYER, head of the department of pharmacology, Harvard University, from the University of Freiburg, Germany.

WILLIAM L. LAURENCE, science editor of the *New York Times*, from Yeshiva University.

FAIRFIELD OSBORN, president of the New York Zoological Society, from Princeton University.

GEORGE W. PERKINS, permanent representative of the U.S. on the North Atlantic Council, who spent many years developing a model program in basic research for Merck and Company, from Princeton University.

HENRY M. STRATTON, publisher of medical textbooks, from the University of Freiburg, Germany.

OSWALD VEBLIN, emeritus professor of mathematics, Institute for Advanced Study, from Princeton University.

HARRY M. ZIMMERMAN, chief pathologist, Montefiore Hospital, Bronx, from Yeshiva University.

HAROLD F. COTTERMAN, dean of faculty at the University of Maryland, has been named dean emeritus. He joined the university in 1917 as a professor of agriculture education. Before his appointment as dean of faculty in 1946, he was also associate dean and dean of education, State supervisor of agriculture

for the State Department of Education, and assistant dean of agriculture.

Cotterman received his B.S. degree from Ohio State University, attended summer school at the University of Wisconsin, and obtained an M.A. degree from Columbia University. He received his Ph.D. degree from American University. He has been president of the Maryland Vocational Association, the Maryland State Teachers' Association, the American Association of University Professors, and the National Education Association.

CYRUS H. FISKE and RONALD M. FERRY, both biochemists, have retired from Harvard University. Fiske, professor of biological chemistry, has made many fundamental contributions to the understanding of the chemistry of living tissues and has discovered numerous biologically important compounds. Fiske's colorimetric method for the determination of phosphorus, which he developed in 1925, is still employed in studies dealing with phosphorus metabolism. Textbooks of physiology and biochemistry lean heavily on his work.

Fiske received the A.B. degree from the University of Minnesota in 1910 and the M.D. from Harvard Medical School in 1914. He was named an assistant in biological chemistry at the Harvard Medical School in 1914, then was appointed (1915) as an associate in biochemistry at Western Reserve University. He became an assistant professor of biochemistry at Western Reserve in 1917, then returned to Harvard in 1918 as assistant professor of biological chemistry. He was appointed professor of biological chemistry at Harvard in 1935.

Ferry, associate professor of biochemistry, through his studies on the viability of airborne bacteria has contributed knowledge of airborne infections which could be valuable in defense against biological warfare. He has also contributed to an understanding of the physicochemical properties of blood.

Ferry worked closely with the late Edwin J. Cohn of Harvard, prior to World War II, in studies of hemoglobin and immunochemistry. During the war, as a lieutenant colonel in the Medical Corps, Ferry had charge of a technical division responsible for chemical and physical defense against possible enemy use of biological agents. He has continued his research in the general area of airborne infections under governmental sponsorship since the war.

Ferry received the A.B. degree from Harvard in 1912 and the M.D. from Columbia University in 1916. He interned at Presbyterian Hospital, New York. Following military service on the Mexican border and as a medical officer in World War I, he returned to Harvard as a research fellow in biological chemistry. He was appointed associate professor of biochemistry at Harvard in 1931. Ferry also has served as master of Winthrop House for 26 years.

WIILLIAM G. COCHRAN, professor of biostatistics at Johns Hopkins University since 1948, has accepted a professorship in the new department of statistics at Harvard University. He is a specialist in sampling techniques and the design of experiments. Under the chairmanship of FREDERICK MOSTELLER, the department will conduct undergraduate and advanced teaching and research in statistical theory and practice and will advise scholars in other fields on the use of statistical methods in their work.

The City College (of New York) Chemistry Alumni Association has announced its Ninth Bicentennial Science Lecture and Medal Award. The medalist will be W. M. STANLEY, Nobel laureate and professor of biochemistry and director of the Virus Laboratory, University of California, Berkeley. He will deliver an address on "Relationships between viruses, genes and cancer" during the annual dinner of the association on 12 Sept. at the Henry Hudson Hotel, New York. The meeting is open to all, and reservations may be made through Dr. Frank Brescia, Department of Chemistry, City College of New York, Convent Ave. and 140 St., New York 31, N.Y.

STANLEY J. SARNOFF, chief of the laboratory of cardiovascular physiology of the National Heart Institute, has been named as the first recipient of a new award for "meritorious investigation in the field of cardiovascular disease and related topics." The $1000 award was instituted this year with a gift made jointly to the Dallas Heart Association and the University of Texas Southwestern Medical School by the Leslie L. and Helen F. Jacobs Foundation.

JAQUES CATTELL has resigned as president of the Science Press, Inc., to take a position as manager of Pergamon Press interests in the United States, with the title of vice president and scientific editor.

ELMER R. WEAVER, chief of the gas chemistry section of the National Bureau of Standards, retired on 31 May after 45 years of service. He is well known in his field, and the techniques he developed for determining the performance of gas-burning appliances are now used as basic procedures in the approval testing of virtually every type of gas appliance sold in the United States.

He was also a pioneer in the development of thermal-conductivity measurements for detecting hydrogen in World War I submarines. This work has now become the basis of a multimillion-dollar instrument industry. In World War II he developed a physical method for measuring the water-vapor content of aviators' oxygen to prevent the clogging of oxygen lines with ice crystals. In 1953, the Department of Commerce recognized Weaver's work by awarding him the gold medal, the department's highest honor. Weaver attended Stanford University, where he was awarded an A.B. in chemical engineering in 1910.

KAREL HUJER, associate professor of physics and astronomy at the University of Chattanooga, is giving a series of lectures this summer in Czechoslovakia at the invitation of the Czech Government. His lectures are on the general topic "The universe of the Mount Palomar Observatory."

Recent Deaths

HARRIET M. ALLYN, South Hadley, Mass.; 74; retired academic dean and professor of anthropology at Mount Holyoke College, former president of the National Association of Deans of Women and the Council of Guidance and Personnel Associations; 7 July.

WALTER G. FRANKENBURG, Lancaster, Pa.; 63; director and vice president in charge of research and development in the General Cigar Company; organized the first purely scientific research laboratory in the American cigar industry; 4 July.

CONRAD NAGEL, JR., Pittsburgh, Pa.; 65; retired vice president of the Aluminum Company of America, formerly its chief metallurgist; made aluminum usable for aircraft by eliminating causes of excessive corrosion; 5 July.

FREDERICK W. PARSONS, New York, N.Y.; 81; psychiatrist, first N.Y. State Commissioner of Mental Health; did notable work on the rehabilitation of shell-shocked veterans; 5 July.

CHARLES H. SAMPSON, Lewiston, Me.; 74; recently associated with Leavitt Institute, Turner, Me., retired professor of engineering and descriptive geometry at Bates College, author of scientific and mathematics textbooks; 6 July.

RICHARD H. SMITH, Alexandria, Va.; 63; retired Department of Defense official, founder and first director of Brazil's Aeronautical Technical Institute, formerly professor of aeronautical engineering at Massachusetts Institute of Technology; 6 July.

JOHN J. STETZER, Philadelphia, Pa.; 82; retired dental surgeon, formerly president of the Academy of Stomatology; 7 July.

Reports

Affinity between the Lupus Erythematosus Serum Factor and Cell Nuclei and Nucleoprotein

The serum of many patients with systemic lupus erythematosus (L.E.) is capable of inducing characteristic alterations in white blood cells *in vitro*. The alterations include swelling of the nucleus of some white cells and the appearance of bodies resembling these swollen nuclei in the cytoplasm of other intact polymorphonuclear leucocytes. The latter cells are known as L.E. cells. How the serum induces these cellular changes has remained obscure. However, the observed morphological changes, the fact that the inclusion body of the L.E. cell stains with Feulgen reagent (*1*) and, in particular, the recent work of Miescher (*2*), strongly indicate a reaction specifically involving cell nuclei. This report presents evidence suggesting that the responsible serum factor combines directly with cell nuclei and nuclear nucleoprotein.

Starch-zone electrophoresis of highly active L.E. serum was carried out. It confirmed the finding of others (3) that the factor migrates with the faster portion of the γ-globulin. Ultracentrifugation of L.E. serum in a sucrose gradient and also in saline solution showed that the factor sediments with the bulk of the γ-globulin with an *s* rate of approximately 7*S*.

Nuclei from calf thymocytes, rabbit polymorphonuclear leucocytes, and human monocytes were prepared in sucrose-calcium solution, sometimes containing citric acid. When each of these types of nuclei was incubated for 30 minutes in highly positive L.E. sera at temperatures between 18° and 38°C and the nuclei then removed by centrifugation, the sera lost completely their ability to induce L.E. cell formation. Electrophoretic and immunological determination of total serum γ-globulin before and after absorption with nuclei showed little change. In one case, the γ-globulin was 20.5 mg/ml before and 19.8 following absorption.

Adherence of the serum factor to the nuclei is suggested by the fact that nuclei which had been removed from L.E. serum, washed with cold saline until the solution was free of protein, and then incubated with fresh human white blood cells, were readily phagocytized to form L.E. cells. Nuclei exposed to normal serum and treated in an identical manner were not similarly phagocytized.

The absorbed L.E. factor could be removed partially from nuclei by incubating the nuclei in isotonic saline for 20 minutes at temperatures from 45° to 65°C. The eluted protein, which was active, was found to be γ-globulin and was quantitatively precipitated by antiserum to normal γ-globulin. The nuclei after elution were still phagocytized to form L.E. cells, indicating that the elution had been incomplete.

In an effort to determine the reactive component of the nuclei, similar experiments were conducted with isolated nuclear nucleoprotein. Nucleoprotein was extracted in 1*M* NaCl. A crystal-clear, viscous solution was obtained from which strands of nucleoprotein could be precipitated by dilution to physiological salt concentration. After absorption with the nucleoprotein, L.E. serum was unable to induce L.E. cell formation. When the nucleoprotein, after incubation with L.E. serum, was washed and incubated with fresh white blood cells, strands of nucleoprotein were phagocytized by the white blood cells to form inclusion bodies very similar to those of the L.E. cells. Nucleoprotein incubated with normal serum or saline was not so phagocytized.

Following treatment with deoxyribonuclease sufficient to remove approximately 50 percent of the deoxyribonucleic acid the nuclei would absorb some of the L.E. factor and would readily release all of that absorbed on subsequent incubation at 56°C. If all the deoxyribonucleic acid was removed with deoxyribonuclease, none of the factor could be absorbed. On the other hand, treatment with ribonuclease did not impair absorptive capacity. After selective removal of the histone by extraction of the nuclei with 0.5-percent citric acid in 1*M* NaCl, the ability of the nuclei to absorb factor remained, but was somewhat diminished.

Exposure of nuclei to normal serum, to cirrhotic serum with very high γ-globulin, and to serum with large amounts of euglobulin did not make the nuclei susceptible to phagocytosis by white cells with formation of L.E. cells, nor did it interfere with their ability to absorb the L.E. factor. However, absorption of factor was prevented by prior treatment of nuclei with protamine, which is thought to bind the phosphate groups of deoxyribonucleic acid, and with atabrine. The latter drug appears to have a therapeutic effect in lupus erythematosus.

Further exploration of the reaction between L.E. serum and cell nuclei was accomplished by studying the L.E. cell reaction by the fluorescent antibody technique during the course of other studies conducted in cooperation with Robert Mellors and Louis Ortega of the Sloan-Kettering Institute (*4*). Slides containing L.E. cells were reacted with fluorescent rabbit antiserum to normal human γ-globulin. Nuclei which were undergoing change preliminary to phagocytosis during L.E. cell formation (Fig. 1) and the inclusion bodies of L.E. cells fluoresced brilliantly. There was no similar fluorescence of the nucleus of the phagocytic cell, or of any nuclei in control preparations made with normal serum. Thus the localization of γ-globulin, presumably L.E. factor, on the affected nuclei during *in vitro* L.E. cell formation could be demonstrated.

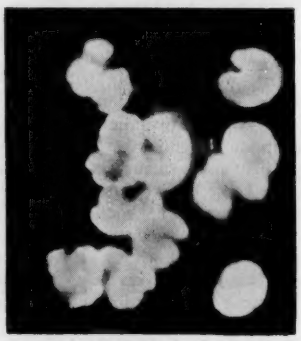

Fig. 1. Visualization of L.E. cell preparation made with L.E. serum and stained with fluorescent antibody to human γ-globulin. Marked fluorescence of swollen white cell nuclei is visible. In identical preparations made with normal serum as controls, there was no nuclear fluorescence.

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).

These data suggest that the L.E. serum factor has an affinity for nuclear nucleoprotein and that deoxyribonucleic acid is involved in the bond. The fact that the L.E. serum factor is a γ-globulin that appears to react with antiserum to normal γ-globulin suggests that the factor may be an antibody. This possibility merits further investigation, with particular reference to the question of whether or not the L.E. factor could be an autoantibody to nucleoprotein or deoxyribonucleic acid.

Note added in proof: Recently we have learned that George Friou of West Haven, Conn., has applied the fluorescent antibody technique to the study of properties of L.E. serum and has obtained results similar to those reported here.

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13 May 1957

Interface Enrichment of Methylene Blue by Fatty Acids with Microanalytic Applications

One of us (G.M.) has observed that thionine dyes are attracted by fatty acids to the interface between alkaline water and water-immiscible fatty-acid solvents. This attraction provides the basis for a convenient new method of measuring very small amounts of certain long-chain fatty acids. In particular, palmitic, oleic, stearic, elaidic, and linoleic acids, separately or in mixtures, have been shown to cause the basic dye, methylene blue, to become enriched at the interface of a two-phase system consisting of a heptane mixture (Skellysolve D) plus methylene blue in ammonia water. The loss of dye from the aqueous bulk phase is a logarithmic function of the amount of such fatty acids in the system. Thus, total concentration of the afore-mentioned fatty acids may be determined by application of this method.

To determine the fatty acids, a solution of 500 μg of methylene blue chloride (minimum assay, 98.5 percent) in 100 ml of 0.6*M* NH_4OH was prepared within an hour before use. Fatty acid working standard solutions containing 100 mμ mole of reagent-grade acid per milliliter of Skellysolve D solution were prepared and kept in glass-stoppered bottles (stoppers were wetted with glycerol to prevent evaporation) away from light. Standard curves for the fatty acids usually were made with mixtures simulating natural fats. Final volumes of 2 ml for the hydrocarbon phase were used in the determinations. Typical standard curves were made by pipetting 0, 20, 40, 80, 120, and 160 millimicroequivalents of the acids into sulfuric acid-dichromate cleaned Coleman spectrophotometer cuvettes (19 by 105 mm round). Into each tube, 6-ml volumes of the ammonia-methylene blue solution were added. All tubes were capped with Saran wrap covered stoppers and shaken 100 times vigorously in a rack. Immediately after this, the cuvettes were placed in a size 2, model V International centrifuge, and the power was adjusted to bring the centrifuge up to 1600 rev/min in 60 seconds; the centrifuge was then slowly braked to a stop. The cuvettes were carefully removed to prevent disturbance of the interface. The optical density was read immediately in a Coleman universal spectrophotometer at 665 mμ. The running of a standard curve with each set of unknowns, and uniform standardization of the procedure, and the maintenance of a constant ambient temperature were found to be very critical factors because this system is not in equilibrium when readings are made.

Table 1 shows typical optical density values observed. These were obtained using a mixture of fatty acids similar to lard (*1*). The precision of the standard curve is indicated by the function showing percentage standard error of duplicate analyses. This function was obtained from the formula

$$\frac{\sqrt{\frac{\Sigma(x_1 - x_2)^2}{2}}}{\frac{n-1}{\bar{x}}} \times 100 = \text{percentage standard error of duplicate analyses.}$$

In this formula,

$$\frac{x_1 - x_2}{2}$$

is the range in millimicroequivalents around the mean of duplicate values, $\bar{x}$; the number of sets of duplicates is denoted by n.

Preliminary studies have shown that this procedure can be used for the measurement of unesterified long-chain fatty acids in plasma (0.2 to 0.5 ml of sample is needed) and of total saturated and unsaturated long-chain fatty acids after alkaline hydrolysis of a 0.1-ml sample.

Furthermore, a check of this method was made on ethanolic KOH saponified samples of lard and sunflower seed oil. The amount of fatty acids found by titration of 4-g fat samples checked within 3 percent of the values obtained using the methylene blue interface enrichment method on aliquots of the lard and sunflower seed oil soaps.

Table 1. Typical optical density values obtained in the determination of total long-chain fatty acids with percentage standard error for duplicate readings. The mixture contained palmitic, stearic, oleic, and linoleic acids in the molar ratios of 5/3/9/1.

Total fatty acid (mμmole)	Optical density	Percentage of standard error for duplicate readings
10	1.030	18.3
20	0.960	4.6
40	0.810	3.6
80	0.525	3.1
120	0.320	6.6
160	0.245	11.2
200	0.220	8.4

It should be stated that caprylic and lauric acids do not cause any observable concentrations of methylene blue at the interface. Moreover, linolenic acid and myristic acids only weakly retain methylene blue at the interface in these procedures. However, iodinated linolenic acid behaves in the same manner as palmitic, oleic, stearic, elaidic, and linoleic acids. Nevertheless, it is evident that this method may be applied for assay of nearly all the long-chain fatty acids in mammalian blood and tissue lipids and in vegetable lipids, except butter and some vegetable fats.

This new method is not only more sensitive but also more practicable than previously available methods for measuring long-chain fatty acids: the materials and equipment required are within the scope of any basically equipped chemistry laboratory.

CHARLES M. COLEMAN
GARDNER MIDDLEBROOK
Department of Research and Laboratories, National Jewish Hospital at Denver, Denver, Colorado

Reference

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26 April 1957

Successive Reversal of a Position Habit in an Invertebrate

The performance of white rats on a series of discrimination reversals based on spatial cues (*1*) has been extensively investigated. These studies show that after a very brief period of negative transfer there occurs a gradual reduction in the number of errors with each succeeding reversal. This interreversal im-

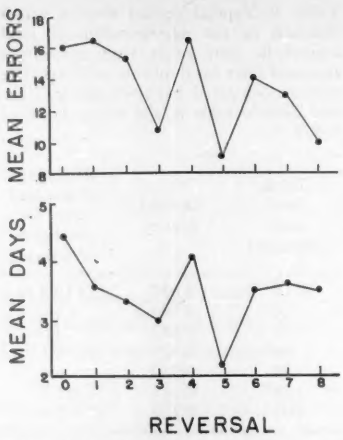

Fig. 1. Mean days and mean errors to criterion as a function of the ordinal number of reversals.

provement might be related to a "learning set" (*2*). The present report suggests that this type of learning set is very difficult to establish in the isopod. The isopod was chosen for investigation primarily because it can survive laboratory confinement for several months, a prerequisite for this type of work, which entails repeated testing of the same subject for a long period of time.

Seven isopods, *Armadillidium vulgare*, were trained on a total of eight reversals of a position habit (*3*). The apparatus consisted of a single-unit T-maze made of transparent plastic. The stem and the arms measured 3 cm in length and 15 mm in width. On the floor of each arm, 1 cm beyond the choice-point, was a grid made from copper wire. A direct current of about 7 μamperes charged the grid. On the floor of each end box was a thin sheet of sponge which was kept moist. A cover was provided for each end box, and the entire unit was painted black on the outside. Under these conditions of darkness and dampness, the isopod rarely attempted exit from the end box once it had made an entrance. Above the choice-point was mounted a 150-w light which constituted the noxious stimulus from which the animal attempted to escape. Prior to testing, all animals were given experience in a straight runway, the construction of which was similar to that of the T-maze.

All animals were required to choose one arm of the T-maze in order to gain access to the dark, moist, end box. Three animals were initially trained to choose the right arm, and the remaining four were trained to choose the left arm. Eight trials were given each day with an intertrial interval of approximately 20 seconds. If the correct arm was chosen, the animal was allowed to proceed to the end box. If, however, the incorrect arm was selected, a shock was delivered to the grid. Response to the shock almost invariably involved an abrupt withdrawal and a reversal of direction of locomotion. When the isopod reached the criterion of seven correct responses on one day, training on the following day was switched to the opposite position (first reversal). Training to this side was continued until the animal again met the criterion of seven errorless trials on one day. On the succeeding day, training was begun to the initially correct side (second reversal). Eight such reversals were given. During the course of the experiment, occasional shedding of the cuticula occurred in all animals. Performance prior to or following this condition did not appear to be impaired.

Figure 1 presents the mean number of days to criterion and the mean number of initial errors to criterion as a function of the ordinal number of reversals. Although a trend suggesting the formation of a learning set is apparent, statistical tests offered no evidence for interreversal improvement. That is, the difference between performance on the first four reversals (or first two reversals) and performance on the last four reversals (last two reversals) was not of sufficient magnitude to indicate that it did not occur by chance. Table 1 presents the individual data for all isopods involved in this study. It will be seen that only two animals (animals 1 and 9) showed definitive changes in performance with increasing reversal experience. It would seem that isopods do not show the characteristic improvement in reversal performance that has been demonstrated for the lower vertebrate forms, such as newts and turtles (*4*). Whether further reversal training would have resulted in a significant degree of improvement and whether a different invertebrate would reveal interreversal gains are problems for future work.

Table 1. Number of errors to criterion for each subject.

Animal No.	Reversal								
	0	1	2	3	4	5	6	7	8
1	24	11	7	0	19	8	9	2	6
2	0	37	1	26	15	14	9	14	4
3	0	47	6	13	17	2	13	24	12
5	34	5	8	17	17	14	6	28	19
7	17	1	16	1	5	3	7	4	11
8	19	1	3	8	7	10	28	10	8
9	17	13	66	9	34	13	25	8	9

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Uranyl Protoporphyrin: a New Uranium Complex

The purpose of this report is to describe a uranyl porphyrin compound that does not appear to be nephrotoxic to mice. Uranyl protoporphyrin is a hitherto undescribed complex of uranyl ion with protoporphyrin 9, the porphyrin ring of hemin.

Uranium in this work was assayed by radiation due to its decay and that of its daughters. Samples were counted in a scintillation well (gammas) and a flow counter (alphas and betas) and compared with appropriate standards. Uranyl protoporphyrin has been synthesized by addition of $UO_2Ac_2 \cdot 2H_2O$ or $UO_2(NO_3)_2 \cdot 6H_2O$ to aqueous protoporphyrin at *p*H 7. The complex precipitates at *p*H's of less than 5. Repeated washes with HCl at *p*H 2 soon lead to constant counts in the precipitate and none in the supernatant; uranyl acetate and nitrate are entirely soluble at *p*H 2. The porphyrin and the activity were entirely in solution after the *p*H had been raised to 7 with NaOH. Allowing the solution to stand at *p*H 7 overnight led to no precipitation of activity; unbound uranyl ion is quantitatively precipitated at this *p*H. Repeated precipitation and solution fails to remove the uranyl ion from the porphyrin ring if a *p*H higher than 8 is avoided. Apparently, sodium uranates form at higher *p*H's and thus destroy the complex. Autoclaving at *p*H 7 in 0.9 percent NaCl destroys the complex; autoclaving in water at the same *p*H does not. Excess citrate ion destroys or prevents the formation of the complex.

Uranyl protoporphyrin is more stable in acid than in alkali; indeed, it has been obtained by refluxing uranyl acetate and protoporphyrin in glacial acetic acid. The complex precipitates on addition of the reaction mixture to water.

Copper in the porphyrin ring is neither

displaced by UO_2^{++} nor does it interfere with formation of the complex. This leads one to believe that UO_2^{++} is not present in the center of the ring.

Uranyl ion forms complexes with many anions. It may be that uranyl ion is bound to protoporphyrin as a complex with the two propionic acid groups which are present on the ring. A uranyl ion might also form a complex with one propionic acid group from two different rings. The nature of this association is not yet clear; that it did not make uranyl ion freely available to the mouse is evident from the data presented in subsequent paragraphs.

It should be emphasized that an equilibrium mixture of U^{238} and its daughters, and not just U^{238} alone, was associated with the porphyrin.

Uranium-238 is an alpha emitter that decays to Th^{234}. This daughter element is a beta-gamma emitter with a half-life of 24.1 days. A sample of pure uranium has no gamma activity associated with it initially, but with time Th^{234} accumulates, and gamma activity increases, becoming constant when equilibrium is attained. Gamma activity from an aliquot of a sample of uranyl protoporphyrin which had been given to mice was found unchanged after 3 weeks. Determination of the amount of uranium present in this sample was performed by comparing its alpha and beta activity with that of a uranium standard. This assay agreed with that obtained by comparing gamma activity. These facts indicate that an equilibrium mixture of U^{238} and its daughters was associated with the porphyrin ring.

Seven white mice (Smith-Webster, 25 to 30 g each) received 9 times the LD_{50} (8 mg/kg) (*1*) of uranium as uranyl protoporphyrin by intraperitoneal injection. They were all alive and growing 30 days later.

Six mice received 3 times the LD_{50} and were all alive and growing 30 days later. Equivalent amounts of uranium as uranyl acetate or nitrate killed all 19 control mice in 3 days. In another experiment, four of five mice given 3 times the LD_{50} as uranyl protoporphyrin were alive and growing after 50 days (see Table 1). Histological studies of livers and kidneys of mice sacrificed 40 hours after they had received 3 times the LD_{50} of uranium as uranyl protoporphyrin showed no histological abnormalities. The control group, which received uranyl nitrate, had showed livers depleted of glycogen and kidneys showing marked tubular destruction typical of uranium poisoning. The uranium-damaged kidneys were obviously larger and paler than the kidneys of normal mice or of mice that had received uranyl protoporphyrin.

It is presumed that uranium as uranyl protoporphyrin has a fate in the mouse entirely different from uranium as the salt. One would expect excretion into the feces via the bile—that is, a fate similar to that of protoporphyrin (*2*).

It has been recognized since 1942 that porphyrins concentrate in tumors, in embryonic tissues, and in inflammatory tissue of human beings and animals (*3*). Since many metal ions complex with porphyrins, it seemed reasonable to expect uranyl ion to do so. One might thus have a method to localize uranium in tumors. Such concentration of uranium in tumors is desirable because neutron capture by U^{235} releases enormous amounts of energy over very short ranges in the form of fission particles. If fission were to take place in a tumor, the tumor might then be destroyed. Therapy of human tumors with neutrons from an atomic reactor is feasible (*4*). Farr *et al.* have treated glioblastoma patients with neutrons following tumor uptake of intravenously administered boron-10 as borate. In this reaction, the destructive effects are attributable to the alpha particles released. Administration of uranium salts to human beings has been found to be too nephrotoxic (*5*). A nontoxic uranium compound that might deposit in neoplastic tissue is therefore of interest.

Studies of the body dynamics of uranyl porphyrins in normal and tumor bearing animals are in progress. The use of porphyrins to prevent uranium toxicity or to decontaminate experimental animals is now being investigated. Use of uranium porphyrins in neutron capture therapy of human tumors after intravenous or local injection might be feasible if further uranium porphyrin toxicity studies are confirmatory (*6*).

Table 1. Survival of mice given equivalent amounts of uranium salts and uranyl protoporphyrin.

Amount of U^0 (LD_{50})*	As UO_2^{++}†			Uranyl protoporphyrin		
	Number of mice		Time (day)	Number of mice		Time (day)
	Survived	Dead		Survived	Dead	
3	0	6	3	4	1	> 50
3				6	0	> 30
6	0	6	3			
9	0	7	3	7	0	> 30

* The LD_{50} is 8 mg of U^0 per kilogram (intraperitoneal injection).
† As acetate or nitrate. This represents approximately 10 mg/kg, a dose far below that lethal for mice when these anions are administered as sodium salts (*7*).

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Nonphotosynthetic Light Requirement in Lemna minor and Its Partial Satisfaction by Kinetin

Gorham (*1*) was able to grow aseptic *Lemna minor* L. in darkness on minerals, sucrose, casein hydrolyzate, and yeast extract, but he found that growth was not maintained by minerals plus sucrose alone. He suggested that normal growth involved light-dependent processes other than carbohydrate production. This is a preliminary report (*2*) on the nonphotosynthetic light requirement.

Lemna minor was grown aseptically in 125-ml erlenmeyer flasks with 50 ml of Hutner's minerals and ethylenediamine tetraacetic acid (*3*), *p*H 6.3, or Gorham's minerals, plus 1 percent sucrose. Stocks kept at 23°C under 16 hours of fluorescent light (400 ft-ca) per day had a frond multiplication rate (MR) (*1*) of approximately 140. Experiments were started with at least 25 fronds per flask, and five flasks were used for each experimental treatment. Dim green light was used for counting and handling in "darkness."

After the plants have remained 5 days in darkness at 26°C, the frond multiplication rate declines to about 10. If a few minutes of red fluorescent light (*4*) are given at this time, the frond multiplication rate for the next 2 days is greatly increased. This effect of red light can be reversed by near infrared radiation (*4*), and is thus probably mediated by the system active in photoperiodism, deetio-

lation, and seed germination (*5*). In a typical experiment (with Gorham's minerals), 40 kerg/cm² (2 min) of red light induced a frond multiplication rate of 79 over the following 2 days; 2 minutes of near infrared radiation immediately following the red reduced the rate to 29, and the "dark" control rate was 8.

The frond multiplication rate in darkness drops again several days after treatment with light, but the promotion of the rate by light can be repeated. Continuous nonphotosynthetic growth on sucrose and minerals alone has now been maintained through five transfers for more than 75 days at an average frond multiplication rate of about 40 by giving 10 minutes of light (less than 200 kergs/cm²) every 3 or 4 days. Fronds so produced are white and bear very short roots. Other experiments (*6*) indicate that the slight growth in darkness implied by the frond multiplication rate of the controls in short-term experiments is in fact the result of residual light effects and of the green light used under "dark" conditions; it is not possible to demonstrate an absolute light requirement except over periods of weeks.

To determine what substances might substitute for light in this system, stock solutions were added to cultures that had been left in darkness for 5 days. Fronds were counted just before treatment and again 2 days after. Although the response to light is more rapid with Gorham's medium than with Hutner's, the latter was used because its trace-element levels and *p*H are more effectively buffered.

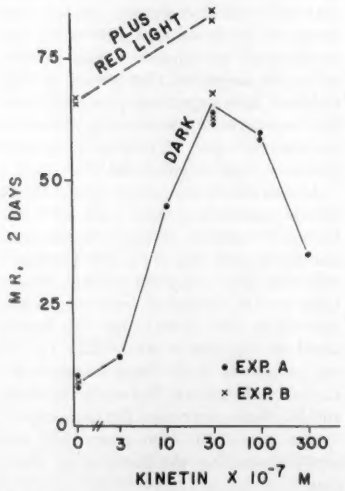

Fig. 1. Effects of kinetin and of red light on growth of *L. minor* in darkness at 26°C. Hutner's medium, *p*H 6.3, 1 percent sucrose. Values from two separate experiments. All treatments were given after 5 days in darkness. Red-light treatment (dashed line) was approximately 400 kerg/cm² (20 minutes). Each point represents a set of five flasks, with initial frond number of at least 140 per set. MR, frond multiplication rate.

Of the substances tried, only kinetin (6-furfuryl aminopurine) (Nutritional Biochemical Co.) and several related compounds produced effects similar to that of light. At the optimal level of $3 \times 10^{-6}M$ (0.645 mg/lit), the effect of kinetin was equal to that of a saturating red light dose, and the effects of kinetin and light together were much less than additive (Fig. 1). Several kinetin analogs (*7–9*) were also tested. The effect of $10^{-6}M$ 6-benzylaminopurine was equal to the optimal kinetin effect, and the effect of $3 \times 10^{-7}M$ 6-benzylaminopurine was 80 percent of the optimal kinetin effect. 6-Benzylthiopurine and 6(2-pyridylmethyl)-aminopurine gave 70 to 80 percent of the optimal kinetin effect at $10^{-5}M$, and both were inactive at 10^{-6} and $10^{-7}M$. 6-Hexylaminopurine and 6-hexylthiopurine were inactive at 10^{-7} and $10^{-6}M$, the former also at $10^{-5}M$. Adenosine at $10^{-4}M$ gave about 20 percent of the optimal kinetin effect, but it was inactive at 10^{-5} and $10^{-6}M$. Cobalt nitrate at $10^{-4}M$ (tested in Gorham's medium) gave 30 to 50 percent of the optimal kinetin effect, but it was inactive at lower levels.

The following compounds were completely inactive at the indicated molar concentrations: arginine, 5×10^{-4}; 4-chlorophenoxyisobutyric acid, 10^{-5} and 10^{-4}; cysteine, 10^{-5} and 10^{-4}; gibberellic acid (Merck), 10^{-7}, 10^{-6} and 10^{-5}; indoleacetic acid, 10^{-7}, 10^{-6}; and uridine, 10^{-5} and 10^{-4}.

These results are of interest in showing that low light doses, probably acting through the photoperiodic pigment system, can completely substitute for the complex organic supplements previously required for the heterotrophic growth of *L. minor*. The substitution of kinetin for light, at least in short-term experiments, confirms the view of Miller (*10*) that the light and kinetin effects are closely related. It seems likely that yeast extract in the complex medium cited served as a source of kinetin (*11*). These results also confirm those of the Wisconsin group (*10, 11*), of DeRopp (*12*), and of Gorton *et al.* (*13*) in showing kinetin activity at molar concentrations of about 10^{-7} to 10^{-4}. Reports have appeared (*7, 14*) of activity at 10^{-9} to $10^{-11}M$, but without comment on such unusual effectiveness. An optimum at about $10^{-9}M$ has been reported (*14*) for the same leaf-disk system that was found by Miller (*10*) to respond optimally at 10^{-5} to $10^{-4}M$.

Unlike the leaf-disk test, *L. minor* is more responsive to optimal kinetin and 6-benzylaminopurine than it is to cobalt. This, coupled with the inability of many other compounds to promote dark growth (see also *1*) suggests the use of *L. minor* for a rapid kinetin assay more sensitive and much more specific (*10*) than the lettuce-seed test (*8*). Finally, since wide differences in the dark growth of various species of Lemnaceae have been reported (*1, 15*), this group should provide valuable material with which to study the relation between light and the activity of kinetin and related substances.

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Stratigraphy of the Wisconsin Glacial Stage along the Northwestern Shore of Lake Erie

Six-year field investigations and laboratory studies of Pleistocene deposits north of Lake Erie (*1*) have provided information sufficient for preliminary conclusions on the Wisconsin stratigraphy of this area. (See Table 1 for the numbers of layers mentioned in text.)

An "early Wisconsin" *glacial cover* is represented by a sandy gray dolomitic till (No. 1) at Port Talbot. It is overlain by varved clay, also rich in dolomite. This glacial substage antedates the classical Wisconsin. Instead of using a new term, I prefer to apply the term *Early Wisconsin* to this post-Sangamon glaciation, as has been done already in Ohio (*2, 3*). This subage may correspond to the early Würm in Europe (*4*, p. 84.)

An interstadial interval followed the glacial retreat, with water level below the present one at first in the Lake Erie basin, rising slightly toward the end of the interval. Highly dolomitic silt, an erosion product of the adjoining till area, became deposited ½ mile south-

west of Port Talbot in shallow lake waters. This silt is intercalated by a lens of gyttja more than 39,000 radiocarbon years old (*5*). Results of pollen analysis indicate a tundra vegetation at the beginning of deposition of the silt, followed by forests of jack pine and spruce. Pollen spectrum of most of the Port Talbot interstadial (except for its thermal maximum, when pines with large pollen grains become abundant) suggests a cool climate with long, cold winters and short, but relatively warm, summers, similar to the present climatic conditions in the Gouin reservoir area in Quebec, lat. 48.5°N., long. 74°W. (*6*).

The Port Talbot interstadial is correlated with the cool climate peat ball in gravels at Amber, Ontario (*7*), greater than 34,000 years old (sample W-194, *8*, p. 486) and with another cool climate interstadial deposit in the St. Lawrence lowland at St. Pierre, Quebec (*9*), older than 40,000 years (*8*, p. 485; *10*, p. 958). If this correlation is correct, the ice sheet must have retreated north of Lake Ontario and the St. Lawrence River. This interval may correspond, at least partly, to a similar long and moderately warm interstadial in Europe that separated the early Würm from the main, or middle, Würm (*4*, pp. 82–83).

A readvance of glacier from the northeast blocked the outlet (the St. David's gorge?) of Lake Erie across the Niagara peninsula, the water level rose, and lacustrine calcareous clay was deposited in the proglacial lake. The glacier advanced at least as far as the central portion of the Lake Erie depression, depositing till No. 2 along its northern shore. This till is thin and discontinuous, and it probably represents a short-lived glaciation that was soon followed by a retreat or stagnation.

Fragments of larch wood and spruce (*11*) 24,600 to 28,200 C^{14} years old (see Table 1) have been found in the third layer of the lower till at Plum Point, 1 mile southwest of the Port Talbot interstadial exposure. Thus evergreen forests returned to the Lake Erie area after the retreat of glacier II. The end of this nonglacial interval occurred at least 14,000 years after the thermal maximum of the Port Talbot interstadial. If the glacial advance II that separates these two interstadials along the north shore of Lake Erie was of a short duration, it may remain unnoticed south of the lake. In such a case, the Port Talbot and the Plum Point interstadials, including the intervening glaciation II, may be considered as a single long interstadial interval farther south.

A different conclusion may be drawn if this stratigraphic problem is worked out from the north. Radiocarbon dates in agreement with those of Plum Point (24,600 and younger), are found south of Lake Erie (*3*, *12*) but nowhere north

Table 1. Wisconsin events in southwestern Ontario along Lake Erie.

No. of glacial cover	Glacial and interstadial subages and principal events	Typical deposits observed	Radiocarbon investigations	
			C^{14} age (yr) and reference	Description and location of sample
IV	*Main Wisconsin glaciation* Formation of moraines during an oscillatory retreat; lacustrine deposits in proglacial lakes.	Lacustrine clay, silt, sand, and gravel; clayey upper till (No. 4).	12,660 ± 440 (S-25, *16*)	Evergreen log in a Lake Arkona or Whittlesey gravel bar at Ridgetown, Ont.
	Last glacial advance over entire lake basin.			
	Retreat of Erie lobe to the eastern portion of the lake.	Lacustrine clay and silt.		
III	Formation of buried moraines during the retreat.	Sandy lower till (No. 3); gravel.		
	Main glacial advance over entire area.			
	Nonglacial interval in the Lake Erie basin.	Evergreen logs in till No. 3.	24,600 ± 1600 (L-217B, *5*) 28,200 ± 1500 (L-185B, *5*) 27,500 ± 1200 (W-177, *8*, p. 485)	Spruce wood Larch wood (Both samples in till No. 3, Plum Point, Ont.)
II	*Short-lived glacial advance* into the Lake Erie basin, preceded by a proglacial lake.	Gravelly lower till (No. 2); gravel; lacustrine clay.		
	Port Talbot interstadial. Lake Erie drainage via Lake Ontario and St. Lawrence River to Atlantic Ocean.	Silt; gyttja; silt.	> 25,000 (S-7, *16*) >32,000 (W-100, *18*) > 38,000 (L-185A, *5*) > 39,000 (L-217A, *5*)	Gyttja at Port Talbot, Ont.
I	*Early Wisconsin glacial* subage with a proglacial lake during the retreat of the glacier.	Varved clay; sandy lower till (No. 3).		

or northeast of Plum Point. This negative evidence suggests (though it does not prove) that forests did not readvance farther northeast. Apparently the ice sheet did not retreat as far north as it did during the Port Talbot interstadial. Lithologic similarities between the tills No. 2 and 3 are also in favor of considering the glacial advance II as the beginning of the main Wisconsin glaciation.

A readvance of glacier from the northeast along Lake Erie deposited a thick layer of sandy gray calcareous till (lower till No. 3, generally called the "lower till" in previous publications).

Fabric studies in till No. 3 reveal gradual changes of the glacial movement: first it was from the southeast, then from the east northeast, and again from the southeast toward the end of deposition. The northeast-southwest movement has been recorded at widely spaced points. Heavy mineral investigations (*13*) suggest this as the principal regional flow during the period of glacial cover III. This flow disregards the east northeast-west southwest trend of the Lake Erie and Lake Ontario basins as guiding factors, thus possibly corresponding to the maximum of the Wisconsin glaciation.

A considerable glacial retreat followed, probably as far as the eastern portion of the lake, and lacustrine clays and silts became deposited through the central and western portions of the lake basin. Most of them become eroded during the following advance of the Erie lobe and were incorporated in the upper till (No. 4), making it more clayey than No. 3.

The following Wisconsin glacial advance IV that covered the entire Lake Erie basin (also in northern Ohio, *14*), deposited the already mentioned brown upper clayey till (No. 4). A great deal of the upper till was laid down during the retreat of the glacier, while it oscillated back and forth, forming morainic ridges. Lacustrine deposits of the proglacial lake became intercalated between two, or even three, layers of till, where the glacier advanced over them. Elevations of abandoned shore lines indicate that the retreat of the glacier, which deposited the upper till, began during Lake Maumee time. Radiocarbon dates of samples W-33 and W-71 (*15*, p. 469), L-217B (*5*), and S-25 (*16*) suggest that the time interval involving deposition of the tills Nos. 3 and 4 was less than 11,000 years. This means that the main Wisconsin glaciation, including even one considerable retreat, was of a relatively short duration in the central and western portion of Lake Erie, if the glacial advance II is not included.

A brief summary on the proposed Wisconsin stratigraphy for the area studied is given in Table No. 1, with temporary local terms, until it is possible to correlate the terms beyond any doubt with generally accepted units of Wis-

consin substages. A possibility is not excluded that till of the glacial advance II was the basal member of the main glacial cover III, as it was once assumed before (*17*), with the Plum Point wood deriving from the closing time of the Port Talbot interstadial interval.

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Effect of 3-Amino-1,2,4-triazole on δ-Aminolevulinic Acid Dehydrase Activity

The conversion of δ-aminolevulinic acid to porphobilinogen is catalyzed by an enzyme (δ-aminolevulinic acid dehydrase) described by Gibson *et al.* (*1*) and Shemin *et al.* (*2*). The activity of this enzyme is reduced in the livers of tumor-bearing animals; in the livers of C57 black mice, it is much lower than it is in the livers of other strains and is not reduced by a rapidly growing, transplanted tumor (*3*). These findings parallel those previously described for hepatic catalase (*4*). This is of particular interest, for catalase is a porphyrin-containing enzyme and δ-aminolevulinic acid dehydrase is involved in porphyrin synthesis. There is no evidence at the moment, however, that in the livers of tumor-bearing animals there is a decreased ability to synthesize protoporphyrin and hence catalase.

Table 1. Effect of 3-amino-1,2,4-triazole (AT) on activity of δ-aminolevulinic acid dehydrase in the livers of DBA mice. The mean value for liver in 47 normal DBA male mice was 47.4 ± 2.6 units (standard deviation). The mean value for liver in six normal DBA female mice was 46.7.

Item	Units (3.15×10^{-3} μmole) of porphobilinogen per hour, per gram (wet weight) at various times (hours) after administration of AT										
	1	1½	2	3	4	8	12	24	32	36	48
					Dose of AT, 1000 mg/kg						
Males	45.2		40.9	35.5		33.0	36.1	37.7	38.8	41.4	
Males	47.3		40.4*	34.5*		32.6	38.8	29.6	38.8	43.1	
Males	47.3					33.4	38.8	25.8			
Mean	46.6		40.6	34.8		33.0	37.9	31.0	38.8	42.3	
Females						29.1	29.1				
Females						29.9	29.2				
Females						29.6	29.9				
Mean						29.5	29.4				
					Dose of AT, 500 mg/kg						
Males								30.8			
Males								31.2			
Males								31.2			
Mean								31.1			
Females	47.1	45.3	48.8		37.8	37.0	22.5	33.0			44.4
Females	44.9	45.3	44.5		34.4	41.0	34.4	36.1			49.7
Females	41.8	44.9	44.5			41.0	37.9	34.3			49.7
								35.7			
								38.3			
								37.4			
Mean	44.6	45.2	45.9		36.1	39.7	31.6	35.8			47.9

* These values were obtained from a homogenate of two livers. All other values were obtained from a homogenate of one liver.

Plant growth is inhibited by 3-amino-1,2,4-triazole, apparently through interference with chlorophyll synthesis (*5*). It was later observed that this compound lowered both plant and animal catalase (*6*). In rats it reduced hepatic and renal catalase activity levels, but not that of red cells, thus producing an effect similar to that observed in tumor-bearing animals.

The ability of 3-amino-1,2,4-triazole to affect two different porphyrin-containing compounds suggests a possible interference with porphyrin synthesis or inhibition of the activity of these porphyrin-containing compounds. The present study was carried out to determine whether the parallel variations of hepatic δ-aminolevulinic acid dehydrase and catalase could be caused by 3-amino-1,2,4-triazole.

DBA mice were injected intraperitoneally with an aqueous solution of 3-amino-1,2,4-triazole. Hepatic δ-aminolevulinic acid dehydrase activity was determined by the method previously described (*1*).

Table 1 shows that 3-amino-1,2,4-triazole reduces the level of hepatic δ-aminolevulinic acid dehydrase activity within 3 to 4 hours. Thus tumors and 3-amino-1,2,4-triazole are capable of causing a decrease in activity of both hepatic δ-aminolevulinic acid dehydrase and catalase.

There are three possible explanations for the effect of 3-amino-1,2,4-triazole on the two enzymes: (i) the triazole or metabolic derivative might react with a chemical group common to both enzymes, resulting in inhibition of their activity; (ii) it might also interfere with porphyrin synthesis in the liver, resulting in a lowered catalase activity level, and (iii) it might interfere with a metabolic pathway necessary for the synthesis of both enzymes. The only exception to the parallel variation of these enzymes is seen after administration of Sedormid, which produces porphyria. Following administration of Sedormid, hepatic catalase activity decreases (*7*), whereas hepatic δ-aminolevulinic acid dehydrase activity increases (*1*).

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11 April 1957

Rapid Method for Measurement of Rate of Sorption of DDT by Mud Surfaces

Malaria control by means of residual applications of DDT and related insecticides to the interior surfaces of homes is now an established practice in many countries of the world. This method of control receives extensive support from the World Health Organization as well as from agencies of the United States Government and other governments. It is now well recognized that in those areas where mud is the predominant building material, residual treatments frequently lose their insecticidal activity at a rate which may seriously jeopardize the malaria control program. When dry mud surfaces are treated with DDT or related insecticides, the adsorption of the insecticide which occurs can result in a loss of most of the biological activity of the deposit in a relatively short time.

Bordas, Downs, and Navarro (*1*), Barlow and Hadaway (*2*), and others have made extensive investigations of this phenomenon. To date, all measurements of loss of activity on mud surfaces have been based on biological methods supplemented with chemical analyses. Such methods are time-consuming and difficult to evaluate.

A rapid method based on the measurement of the loss of radioactivity of mud surfaces dusted with C^{14}-labeled DDT is described in this report. Because the C^{14}-labeled compound migrates to a depth only slightly beneath the surface, the weak beta rays are shielded; thus it is possible to follow the loss from the surface by measuring the loss in radioactivity. This technique lends itself to the rapid screening of substances which may deter or prevent adsorption.

Samples of mud for this study were obtained from Savannah River deposits, Guatemala, and Colorado. The samples were air-dried, ground in a mortar, and passed through a 30-mesh sieve. This powder, which was made into a thick paste by adding water, was pressed into cylindrical molds 24 mm in diameter and 6 mm deep. After drying in air for several days, the resulting mud cakes were removed from the molds.

One-third of the mud cakes were placed over silica gel in a desiccator; another third were kept over sulfuric acid solution (specific gravity, 1.35; atmosphere of 47 percent relative humidity); and the balance were kept over sulfuric acid solution (specific gravity, 1.10; atmosphere of 94 percent relative humidity). The cakes were allowed to equilibrate in the humidity-controlled atmospheres for several days.

The powdered DDT used for dusting the mud cakes was prepared by mixing 990 mg of pure *p,p'*-DDT with 9.8 mg of radioactive *p,p'*-DDT (specific activity 0.48 mc/g). The mixture was made homogeneous by adding sufficient CCl_4 to dissolve all the DDT and evaporating the solvent. After drying over silica gel, the residue was ground to a fine powder in a glass mortar. The powdered DDT was placed in the bottom of a glass tower especially designed and constructed so that dry nitrogen could be blown over the powder. The mud cakes were placed in the upper part of this apparatus. When the nitrogen gas was introduced, fine particles of radioactive DDT fell on the mud samples. The particles were measured under a microscope and were found to range from 1 to 25 μ in size, with an average diameter of 6.2 μ. About 1 mg of DDT was dusted onto each cake.

Immediately after dusting, the radioactivity of each cake was counted in a conventional gas flow counter, and the cake was returned to one of the humidity-controlled desiccators. The cakes were recounted at intervals of 1 to 5 days. Samples were counted from 1 to 3 minutes, depending on the counting rate, and were taken from the desiccators only long enough to be counted. In all cases, the count was repeated until an agreement within 3 percent was reached. The average initial count was 4220 count/min.

Within 24 hours, a measurable decrease in radioactivity was observed in all samples. The count for samples kept in the dry atmosphere dropped sharply, with an average loss of 15.2 percent after 1 day. Samples kept in an atmosphere with 47 percent relative humidity had an average loss of 7.6 percent for the same period, while those kept in the high humidity lost an average of only 4.2 percent. Samples of mud from the three sources were observed for approximately 2 weeks. The rate of loss was about the same for all types of mud tested under identical humidity conditions. The decrease in radioactivity with time for a typical series of samples (Savannah River mud) is shown graphically in Fig. 1. Here the effect of humidity is clearly shown.

On the tenth day, sample 22, which had previously been kept in a dry desiccator, and sample 24, which had been kept at 47 percent relative humidity, were transferred to the high-humidity desiccator. Subsequent measurements of these samples showed increased activity. This was repeated on many other samples with the same result. These observations seem to confirm those of Bordas, Downs, and Navarro (*1*) who claim that desorption occurs in periods of high humidity and that insecticidal activity then returns to surfaces which have previously lost their activity because of adsorption.

After the DDT-dusted cakes had stood for approximately 30 days, the top layers were carefully scraped off, 0.5 mm at a time. These scrapings were extracted with acetone and analyzed for DDT by the Schechter-Haller (*4*) method. Analyses of scrapings from samples maintained at 94 percent relative humidity showed an average of 98.0 percent of the DDT to be in the first 0.5-mm layer; 1.4 percent in the second 0.5-mm layer; and 0.6 percent in the third 0.5-mm layer. In similar analyses of scrapings from samples kept at 47 percent relative humidity, 90.7 percent of the DDT was found in the top layer; 7.1 percent in the second layer; and 2.2 percent in the third layer. Scrapings from samples from the dry desiccator averaged 81.9 percent, 15.3 percent, and

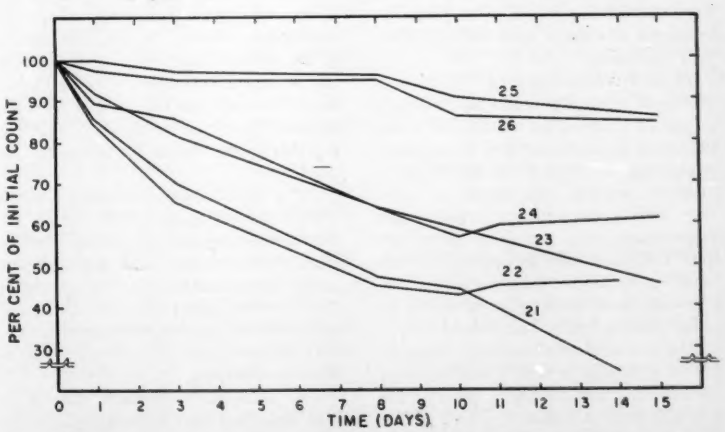

Fig. 1. Rate of loss of radioactivity. Samples 21 and 22 were held in a dry desiccator; samples 23 and 24 were kept at a relative humidity of 47 percent; samples 25 and 26 were kept at a relative humidity of 94 percent. On the tenth day samples 22 and 24 were transferred to a desiccator with a relative humidity of 94 percent.

3.5 percent in the three layers, respectively. Apparently the maximum penetration into the mud cakes was only slightly more than 1 mm even in a dry atmosphere. No DDT was found in layers below a depth of 1.5 mm.

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9 May 1957

Selection of Auxotrophic Bacterial Mutants through Diaminopimelic Acid or Thymine Deprival

The significance of unbalanced growth as a cause of cell death has been brought out by Cohen and Barner (*1*), who worked with a thymine-requiring mutant of *Escherichia coli*. When this organism was incubated in a culture medium that lacked thymine, it could not form deoxyribonucleic acid but continued to synthesize its other cell constituents, and, as a result, the viable count fell rapidly. Recently, Lederberg (*2*) found that unbalanced growth similarly underlies the bactericidal action of penicillin. When a suitable protective agent (such as hypertonic sucrose) was added to the growth medium, penicillin no longer caused lysis but, instead, led to protoplast formation. It could be concluded from this observation, as from the independent biochemical findings of Park and Strominger (*3*), that penicillin interferes selectively with bacterial cell-wall formation.

These developments suggested the possibility of replacing penicillin in the selection of auxotrophic mutants of bacteria. In the penicillin method (*4*), a mixed population is exposed to this drug in minimal medium, whereupon the wild-type cells grow and are lysed, while auxotrophic cells, unable to grow, are spared. We now wish to report two modifications of this procedure which utilize a genetic block rather than penicillin to make growth fatally unbalanced.

The first method closely resembles the use of penicillin in that it also involves the cell wall. The method is based on the availability of a mutant (173-25 of the W strain of *E. coli*) that is blocked in the synthesis of *meso*-α,ε-diaminopimelic acid (DAP) (*5*). In certain bacterial species this compound is a cell constituent (*6*) as well as a precursor of lysine (*5, 7*), and analyses of bacterial fractions have suggested that its incorporation as a constituent may possibly be limited to the cell wall (*8*). This suggestion is supported by the results of incubating mutant 173-25 in media that contained lysine but no diaminopimelic acid: the cells lyse in a medium of ordinary tonicity (*9*) but form protoplasts when 20 percent sucrose is also present (*10*). Deprival of diaminopimelic acid thus results in selective interference with cell-wall formation.

To use this "suicidal" property of mutant 173-25 in the selection of mutants with additional requirements, a procedure similar to the penicillin method (*4*) was followed. The bacteria were irradiated with ultraviolet light to about 1 percent survival. For phenotypic expression of the resulting induced mutations, large inocula were cultivated overnight in minimal medium A (*11*) enriched with 10 μg of diaminopimelic acid (*12*) per milliliter and with 0.2 percent tryptic casein hydrolysate (Sheffield NZ–Case) and 0.2 percent yeast extract (Difco). For selection of auxotrophic mutants, the cells were then washed and incubated (10^5 to 10^7 cells per milliliter) for 14 hours at 37°C in medium A supplemented with 20 μg of L-lysine per milliliter (*13*). Survivors were recovered by plating in the enriched medium described, solidified with 1.5 percent agar. Mutant colonies were recognized by the inability of subinocula to grow on minimal medium supplemented with only the compounds required by the parental strain (*14*).

The second method involves the metabolic imbalance originally described by Cohen and Barner and utilizes the same thymine auxotroph (15T⁻). The procedure used was the same as that described in the preceding paragraph except for appropriate changes in the composition of the media. Thus, selection was carried out in minimal medium A, and all other steps were carried out in this medium supplemented with thymine (20 μg/ml), together with other supplements as needed.

In a small-scale experiment, strain 173-25 yielded mutants with various additional requirements: cystine, methionine, *p*-aminobenzoic acid, arginine plus uracil, and an unidentified factor. Strain 15T⁻ yielded offspring with additional requirements for arginine, methionine, phenylalanine, and a mixture of aromatic metabolites.

The alternative methods that have been described may have advantages, in certain circumstances, over the use of penicillin. In particular, it is known that "thymineless death" can be produced by a method that is capable of quite general application: by using a sulfonamide antagonist of *p*-aminobenzoic acid to prevent the synthesis of a group of products of one-carbon metabolism and simultaneously providing all these products except thymine (*1, 15*). The present work (*16*) suggests that production of thymine deficiency in this way might be useful for selecting mutants of organisms (such as yeasts) that are susceptible to sulfonamides but indifferent to penicillin.

The use of penicillin for the selection of auxotrophic mutants of bacteria can be replaced by taking advantage of the fact that a DAP-requiring or a thymine-requiring strain is suicidal when it grows in media that lack the required compound (*17*).

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12. For samples of *meso*-α,ε-diaminopimelic acid we are indebted to Charles Gilvarg, to Lemuel Wright of Merck, Sharp and Dohme, and to Chas. Pfizer and Co. This supplement is necessary since the complex enrichments used do not contain detectable amounts of DAP.
13. Presumably, as in the penicillin method [see J. Lederberg, *Methods Med. Research* 3, 5 (1950)], longer or shorter periods of incubation would also be satisfactory.
14. The supplement contained L-lysine (20 μg/ml) as well as DAP (10 μg/ml), since strain 173-25 has a relative requirement for lysine as well as an absolute requirement for DAP (*5*).
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17. A similar method has proved useful in the isolation of mutants of the molds *Ophiostoma* sp. and *Aspergillus* sp., since the survival of certain auxotrophs of these species, when incubated in minimal medium, is significantly prolonged by the presence of various additional metabolic blocks. [See N. Fries, *Hereditas* 34, 338 (1948); G. Pontecorvo, *Advances in Genet.* 5, 141 (1953)].

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3 May 1957

Book Reviews

The Life and Death of Cells. Joseph G. Hoffman. Hanover House, Garden City, N.Y., 1957. 301 pp. $4.50.

Here is a biophysicist's fresh approach to the problem of the life and death of cells. Among the topics considered are, what is life?, living tissue cells, automation in cells, organization and flux in cells, effect of environment on cells, cell division, variations and mistakes (in cell division), cancer cells, submicroscopic fibers, growth and death as stochastic processes, physical forces, and the importance of death. In many cases the problems are discussed with vivid imagery, particularly with respect to cellular movement and underlying molecular movements; for example, "There is literally a simmering and throbbing of the cytoplasm. It appears to be a boiling vortex of matter, even though it is known to be mostly water." Or again, in connection with the effects of ionizing radiations: "There is, however, one physical agent which strikes through the defences of a cell and can blast it like a bolt of lightning." Staid statements are often given zest by calculations and extrapolations; for instance, "A tissue cell may have a voltage across its walls of 50 millivolts . . . a rate of change of voltage of 50,000 volts per centimeter . . . across the wall."

Among the interesting discussions are those on the relationship between mistakes in heredity and the number of cell generations intervening between zygote and adult. The mistakes which occur only infrequently are considered to be one of the causes of cancer. There is also an intriguing chapter on physical forces, reactivity, enzyme specificity, macroscopic force fields, van der Waals forces, and Coulombic forces as possibilities for the explanation of some cellular phenomena. The last chapter, on death, includes an interesting discussion of the template hypothesis of duplication of biological units. The treatment of cells in tissue culture and the problems of cancer appealed to me as being especially original and informative.

A few unfortunate slips are found—for example, the failure to follow convention in capitalizing only generic names, not specific names, of animals and microbes. Also, a statement like: "When a plant or tree makes ten thousand seeds, it must assume that there will be more than barren rocks to greet the seeds," may raise eyebrows, as will the acceptance of the evidence that grain from ancient Egyptian tombs will sprout on being planted. A person who wants authority for various interesting statements regrets the lack of citations to the literature, but the book is apparently intended for the general reader, not the specialist. However, all in all, its merits far outweigh its minor deficiencies, and *Life and Death of Cells* should provide interesting reading matter for the large number of individuals who are intrigued by the ways of cells.

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Algebraic Geometry and Topology. A symposium in honor of S. Lefschetz. R. H. Fox, D. C. Spencer, A. W. Tucker, Eds. Princeton University Press, Princeton, N.J., 1957. 408 pp. $7.50.

Algebraic Geometry and Topology is a volume dedicated to S. Lefschetz on his 70th birthday (3 September 1954) by his students and friends. Lefschetz's main contributions to pure mathematics lie in the fields of algebraic geometry and algebraic topology, which thus become the subject of this book. One would like to add that, in the past 15 years, Lefschetz has been mainly interested in the theory of ordinary differential equations and has exerted a considerable influence in its development, although the subject is not touched on here.

The book starts with articles by W. V. D. Hodge and N. E. Steenrod which summarize, in a vivid fashion, the essential contributions of Lefschetz to algebraic geometry and topology. The remainder of the book contains 12 papers on algebraic geometry (in its broad sense) and 11 papers on topology. All of these are original papers on current developments in the two fields. There is also a bibliography of 98 items, covering Lefschetz's mathematical publications, which includes several books and sets of lecture notes.

Both Hodge and Steenrod admit the benefit they have derived from studying Lefschetz's work. Hodge acknowledges his indebtedness for the stimulus to his ideas on harmonic integrals, and Steenrod, for a treatment of some cohomology operations, known as reduced powers, which he introduced. These are certainly the best possible tributes to a great mathematician, the more so since these contributions of Hodge's and Steenrod's are among the most important in modern mathematics.

The contributed papers cover a wide range. It may be of interest to observe that many of them have contact with some phase of Lefschetz's work.

This book will be an indispensable piece of mathematical literature. It appears at a time when both algebraic geometry and topology are in the process of a vigorous development. Algebraic geometry has extended itself, on the one hand, to complex manifolds and differential geometry and, on the other hand, to abstract algebraic geometry and number theory. In recent years, algebraic topology has been closely interwoven with algebra, particularly with the so-called homological algebra. The basic problem in mathematics, as in many other fields of science, is the relation between the discrete and the continuous. A topological space is a continuous object, but the algebraic structures associated with it, the homology groups, the cohomology ring, and so forth, are generally discrete. An algebraic variety in the complex field has a topological structure, but an abstract variety in a finite field is basically discrete. We see, in the recent development of algebraic geometry and topology, this interplay of the discrete and the continuous on a high level. It must be for this reason that the field, like the work of Lefschetz himself, occupies such a central position in pure mathematics.

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Chemical Applications of Spectroscopy. vol. IX of *Technique of Organic Chemistry*. W. West, Ed. Interscience, New York, 1956. 787 pp. Illus. $15.

The past decade has witnessed remarkable increases in both the importance and diversity of applications of spectroscopy for the practicing organic chemist. Perhaps the most striking development has been the creation and almost explo-

sive growth of the virtually new fields of radio and microwave spectroscopy. The great usefulness of some of the newer techniques and the ready availability of excellent commercial instruments has encouraged or induced many organic chemists to become part-time spectroscopists as well. More often than not, however, their background and formal preparation in spectroscopy have been limited. For this reason, a book which provides the nonspecialized worker with a broad yet reasonably detailed survey would meet a distinct need. This *Chemical Applications of Spectroscopy* attempts to do.

The editor, W. West, has contributed an introductory survey of molecular spectra and a chapter on fluorescence and phosphorescence. Microwave and radio-frequency spectroscopy is the subject of a chapter by Walter Gordy. A. B. F. Duncan has contributed a chapter on the theory of infrared and Raman spectra and a section that deals with the theory of electronic spectra. A very comprehensive chapter on the application of infrared and Raman spectrometry to the elucidation of molecular structure has been contributed by R. Norman Jones and Camille Sandorfy.

Although issue may be taken with the balance among the subjects covered and with the approaches adopted by some of the authors, there can be no doubt that this book contains a sufficient range of information to be of some value to practically every organic chemist who uses spectroscopy as a tool. Among the book's limitations, one of the more prominent is the unevenness of the chapters. The background required of the reader varies quite widely. In some instances, the reader is given guidance, perspective, and a critical review of current methods and applications. In other portions of the book, the reader is left adrift in a straightforward but heavily mathematical exposition which would seem better suited to a more specialized text. Despite these and related faults, which tend to diminish the book's usefulness to the readers for whom it was expressly intended, it should prove helpful and informative.

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The Importance of Overweight. Hilde Bruch. Norton, New York, 1957. 438 pp. $5.95.

Hilde Bruch's new book, *The Importance of Overweight,* is an original and vigorous contribution to the understanding of this subject. As can be expected from her training and experience as a psychiatrist, the parts of her book which deal with analysis of the psychological aspects of obesity are immeasurably superior to her chapters on the physiological side. Bruch was one of the first psychiatrists to recognize that obesity is not simply the result of willful abandonment of self-control but that overeating corresponds to some profound physiological or psychological disturbances. She speaks of the psychological and emotional aspects of the obesity problem with the voice of a compassionate physician and a research-minded scientist rather than in the dogmatic and intolerant tone that is too often associated with the subject.

However, the subject of obesity has so many facets—physiological and nutritional as well as psychological—that it is unlikely that one person could ever write on all of it with steady excellence.

The chapter on "The cultural frame," which deals with past attitudes of various civilizations toward obesity, is particularly entertaining and well illustrates how the same condition has been considered, at times, an enviable attraction and, at other times, a hideous disfigurement. On the other hand, the development in the next chapter of "What is overweight?" is rather cursory. Bruch's concept of a "preferred weight," "to which people seem to cling in such a stubborn way," is unconvincing. Under uniform conditions of exposure to food and physical activity, and in the absence of acute disease or psychological trauma, the weight of people does indeed vary slowly, but any sudden change in mode of life can have rapid effects on weight and may never be followed by a return to the previous level.

The chapter on "The case for heredity" places in their respective interrelationship the genetic and environmental factors; that on "Physical growth in obesity" calls attention to some of the many problems involved in gaging the effect of a relative hyperphagia on growth.

The chapter on "Basic facts on basal metabolism," although it represents a recognition on the author's part of the many difficulties that are encountered in interpreting respiratory measurements in obese individuals, is superficial and contributes little to clarification of this problem.

The chapter on "Metabolic and regulatory disturbances" attempts to deal with some of the recent concepts developed, in particular, by T. B. Van Itallie and me. Unfortunately, the distinction between the two terms *metabolic disturbances* and *regulatory disturbances* does not appear to have been clearly understood by the author, and her chapter may not be very helpful to students of the physiological aspects of obesity. By contrast, the series of chapters which deal with the psychological aspects of obesity is excellent and illustrates well the fact that obesity admits of a multiple etiology, with regard to psychological as well as to physiological factors. As a clinical problem obesity can only be dealt with when it is realized that the many causes of this condition may have very little in common except their ultimate effect. It follows that each case of obesity must be dealt with according to the characteristics of the individual patient. Ready-made general solutions are likely to do more harm than good.

One may regret that Bruch, who was among the first to emphasize the importance of physical inactivity in the etiology of obesity in children, has not devoted more space to this aspect in her book. A chapter specifically devoted to a discussion of psychological causes and possible remedies for the lack of willingness to exercise that is evidenced by so many obese children would have been particularly helpful.

The book is well printed and edited. It has a good bibliography and a useful index. It is the first book which seriously attempts to deal with the underlying causes of obesity since that of Rony appeared in 1940. It has its place in the library of any worker who is concerned with this important health problem.

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Synthetic Polypeptides. Preparation, structure, and properties. C. H. Bamford, A. Elliott, and W. E. Hanby. Academic Press, New York, 1956. 445 pp. Illus. $10.

There has been phenomenal progress in the study of large, synthetic polypeptide molecules in recent years, and probably no group of workers has contributed more than those associated with the research laboratory of Courtaulds, Ltd., in England. The authors of this monograph are leading representatives of that group, and this survey of the field presented by them is naturally an important contribution. Their objective, stated in the first chapter, is "to present detailed evidence about synthetic polypeptides which has a bearing on some aspects of the structure and behavior of the protein molecule." After this introduction, they devote two chapters to the methods of synthesis of polypeptides and to the mechanisms involved in syntheses, starting from N-carboxy-α-amino acid anhydrides.

The following chapter IV deals with chain configuration in polypeptides, including the α helix and other helices, the pleated sheets, and other configurations. Chapters V and VI deal in great detail with the infrared spectroscopy of the

polypeptides, with strong emphasis on the significance of dichroism in polypeptide spectra. Chapters VII, VIII, and IX present a detailed discussion of x-ray diffraction studies. These chapters on infrared and x-ray studies are particularly significant, as might be expected in view of the major contributions of the authors and their associates in these fields. Chapter X discusses the physical properties of synthetic polypeptides, with extensive tabulations of data. Chapter XI (by S. G. Waley) gives a very brief discussion of the biological properties of synthetic polypeptides. Chapter XII, on fibrous proteins, deals only with silk fibroin and keratin; the authors refer, in passing, to the recent major advances in our understanding of the structure of collagen.

The book covers the development of the field up to approximately the beginning of 1956. Subsequent progress has been so rapid that many very recent contributions of major importance—including some from the authors of this book—could not be included. In particular, recent outstanding developments in optical rotation and rotatory dispersion have occurred since the book went to press. This should be allowed for in judging the contents.

Certainly the book is a major contribution in its field. The authors do an admirable job in the presentation of work from their own laboratories; for others interested in the field, it will be of great assistance to have the coordinated presentation given here, which will save much searching in the original literature. But it must be added that the presentation is definitely one-sided. Although the list of references is, on the whole, comprehensive, the discussion, in my judgment, frequently fails to do justice to the importance of the work from other laboratories. For example, the recent work of Katchalski, Shalitin, and Gehatia (1955) on polymerization kinetics is dismissed in two brief sentences on page 100. Readers who are unfamiliar with the field would never realize, from this, that the work in question gives a detailed theoretical analysis of the kinetics of formation of polypeptides from N-carboxy-α-amino acid anhydrides, which includes, as special cases, some of the treatments given at length in the present book. Even this theory is probably not general enough to cover all the important cases that arise in practice, but its importance calls for detailed consideration in any comprehensive treatment. A later paper by Katchalski, Gehatia, and Sela [*J. Am. Chem Soc.* **77**, 6175 (1955)], which presents a statistical analysis of molecular weight distributions of linear and multichain polyamino acids, is not even mentioned, although it is certainly a major contribution. Other similar examples could be given of important work from other laboratories which is treated sketchily or not at all in this book. Although there is an extensive tabulation in chapter X of the solubility of synthetic polypeptides in various media, very little is said concerning the properties of the resulting solutions. There is no discussion, for example, of the extensive studies of acid-base equilibria in solutions of synthetic polypeptides, which have been carried out by Katchalski and his associates.

In view of these criticisms, I cannot regard this book as a truly comprehensive and balanced presentation of the present state of research on synthetic polypeptides. It contains, however, a very admirable survey of a large amount of material, with special emphasis on the work of the authors and their associates, and research workers who are seriously interested in the field of synthetic polypeptides will undoubtedly find it indispensable.

The make-up of the book is excellent, the figures are numerous and clear, and there is an extensive and useful index.

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A Glossary of Mycology. Walter H. Snell and Esther A. Dick. Harvard University Press, Cambridge, Mass., 1957. 171 pp. + 15 plates. $5.

A Glossary of Mycology lists and defines some 6000 terms which are or have been in use in mycology. Included are the names of antibiotics, pigments, and other metabolic products as well as the names of structures, adjectives used in technical descriptions, and common names applied to various fungi. The derivations of most of the words are given, and the entries are cross-referenced. In the case of highly specialized or restricted terms, a brief reference is given to the work in which the word was first used or to a source of a more extensive definition. The authors have remained objective and dispassionate lexicographers throughout the book, and only in rare instances have they indicated a preference between synonyms.

Beginners in systematic mycology will appreciate the 15 plates of simple, clear figures illustrating various kinds of fruiting bodies, spores, and other structures.

Another feature of the book that should appeal to systematists in this country is that approximate equivalents from Ridgway's *Color Standards* are given for the color terms in the *Repertoire de Couleurs*. Although these approximations are of necessity subjective, their inclusion will aid workers who do not have access to the latter work.

Although *A Glossary of Mycology* is less ambitious than Ainsworth and Bisby's admirable *Dictionary of the Fungi* in that it does not list the scientific names of genera and other taxa, it contains more definitions, and this completeness, together with its expanded definitions and clear illustrations, makes the book useful both for the professional scientist and for the serious amateur student of the fungi.

ROBERT M. PAGE
Stanford University

A Manual of Soil Fungi. Joseph C. Gilman. Iowa State College Press, Ames, Iowa, rev. ed. 2, 1957. 450 pp. Illus. $7.50.

It has long been known that many different kinds of fungi inhabit the soil. Most of these are important as the agents of decay, others as facultative parasites on plants or animals. After it was discovered that some of these saprophytic fungi could be domesticated and used by man in the production of drugs and other commercially important products, interest in the inexhaustible reservoir of soil fungi increased enormously. Although there were many monographs on genera and families some of whose members were soil inhabitants, there was no single work on soil fungi as a whole. It was to fill this urgent need that Gilman and Abbott started a systematic study of soil fungi in the early 1920's. In 1927 the results of their studies were published in a 118-page paper, *A Summary of Soil Fungi*, in which 61 genera and 242 species of fungi were described, 20 of them new. The demand for this was so great that the supply of copies was soon exhausted.

The first edition of *A Manual of Soil Fungi*, published in 1945, was a revision and extension by Gilman of this early paper. The present volume is a revision and extension of the 1945 edition. In the first edition, 139 genera and 795 species are described; in this one, 170 genera and 917 species. As in the first edition, the book is mainly a compilation of the work of others. The manual is intended as a tool to assist investigators in identifying soil fungi.

The author includes chiefly those species of fungi which have been isolated from soil and cultivated artificially. The terrestrial mushrooms and many plant and animal pathogens which may be soil-borne are excluded, as are many wood-decay fungi. The Actinomycetes, Myxomycetes, and Zoopagaceae are also omitted. More than half of the descriptive part of the book is devoted to the Fungi Imperfecti, which contain many of the commoner and more important soil fungi and the ones

that are the most difficult to find in the literature. One hundred and fifty pages are given to the Phycomycetes; a large number of these are devoted to the Mucorales and based on Zycha's monograph, which is in German and is not available to many workers. The Ascomycetes are covered in 36 pages, and the Basidiomycetes in one. Many of the species that are described here are important in medicine and industry and as the agents of food spoilage. Some cause the deterioration of cellulose, leather, and other important products.

Following the descriptive text is a list of pertinent literature, with 245 titles and a glossary of several hundred terms. The book is well furnished with usable keys for identification, down to the species. The descriptions are well written, and line drawings illustrating the genera, and 13 plates of photomicrographs, add greatly to the book's usefulness.

JOHN N. COUCH

University of North Carolina

The Study of Plant Communities. An introduction to plant ecology. Henry J. Oosting. Freeman, San Francisco, Calif., rev. ed. 2, 1956. 440 pp. Illus. $6.

The appearance of a second edition of *The Study of Plant Communities* is a matter of great interest to students of vegetation and to other ecologists. An eminently readable book, suitable for an introductory course in synecology (of plants), it seems also to be the most satisfactory presentation available of much of the current thinking of the American school of plant ecology. This is one second edition that is definitely not a mere reprinting of the earlier edition. It has been critically rewritten; the author has profited from criticisms of the first edition and incorporates freely from the results of the present active period of thinking and publishing in the field.

Especially welcome are the full discussion and comparison of the monoclimax and polyclimax ideas, although one could have wished that the treatment of polyclimax had been as well integrated and sympathetic as that of monoclimax. The introduction of the ecosystem concept is an important innovation, although it is touched on much more lightly than the publisher's advertising leads one to expect. Also very valuable is the greatly expanded bibliography, abundantly referred to throughout the text. This suffers seriously, however, from the usual American weakness of completely inadequate inclusion of foreign literature. Only seven items in languages other than English are included, and five of these are classics. It is doubtful that the provincialism of American natural science and the ineptitude with languages of American scientists will ever be significantly lessened as long as authors of the most important textbooks continue to convey the impression that a student can get along perfectly well with only a knowledge of English.

Little attention is paid in this book to the several European schools of phytosociology. True, the Braun-Blanquet school is mentioned, and certain of its concepts and methods of collecting data are described. However, its basic philosophy, its recent development, and its important contribution to the plant indicator concept are not touched on. And, in the current passion for objectivity, the greatest contribution of Braun-Blanquet —the subjective selection of plots—is not even mentioned. This amounts to a recommendation that the best tool available to the phytosociologist, the trained human mind, be neglected. However, the repeated emphasis elsewhere in the book on the importance of good judgment suggests that such is not really the intention of the author. The fine chapter on applied ecology also suggests that the author himself has brought to his work a first-class intellect and has made exceptionally good use of it.

In general, this volume can be highly recommended, both as a textbook for students and as an exposition of the views of the American school for other scientists and foreign professionals. It will not meet the philosophic objections of some of the critics of the earlier edition, since the author's own philosophy has not changed. But the material that is presented may actually be more within the grasp of the audience for whom it was intended in its present form than if the approach had been strictly from a holistic viewpoint.

F. R. FOSBERG

Falls Church, Virginia

New Books

Recent Advances in Anaesthesia and Analgesia (including oxygen therapy). C. Langton Hewer and J. Alfred Lee. Little, Brown, Boston, Mass., ed. 8, 1957. 303 pp. $8.50.

One Man's Life with Barley. The memories and observations of Harry V. Harlan. Exposition Press, New York, 1957. 223 pp. $6.

Theories of Nuclear Moments. R. J. Blin-Stoyle. Oxford University Press, London, 1957. 89 pp. $1.40.

Principles of Immunology. John E. Cushing and Dan H. Campbell. McGraw-Hill, New York, 1957. 343 pp. $6.50.

Geologic Field Methods. Julian W. Low. Harper, New York, 1957. 504 pp. Professional edition, $6; text edition, $4.50.

Hospital Treatment of Alcoholism. A comparative, experimental study. Menninger Clinic monograph ser. No. 11. Robert S. Wallerstein and others. Basic Books, New York, 1957. 223 pp. $5.

Visual Methods in Education. W. L. Sumner. Philosophical Library, New York, ed. 2, 1957. 231 pp. $6.

The Demand and Supply of Scientific Personnel. David M. Bland and George J. Stigler. National Bureau of Economic Research, New York, 1957. 219 pp. $4.

The Principles of Heredity. Laurence H. Snyder and Paul R. David. Heath, Boston, Mass., ed. 5, 1957. 518 pp. $6.25.

The American Teenager. H. H. Remmers and D. H. Radler. Bobbs-Merrill, Indianapolis, Ind., 1957. 267 pp. $3.75.

Introduction to Electrical Applied Physics. N. F. Astbury. Philosophical Library, New York, 1957. 252 pp. $10.

Analytical Microscopy. Its aims and methods in relation to foods, water, spices, and drugs. T. E. Wallis. Little, Brown, Boston, Mass., ed. 2, 1957. 215 pp. $5.50.

The Biological Action of Growth Substances. Symposia of the Society for Experimental Biology, No. XI. Academic Press, New York, 1957. 351 pp. $9.50.

The Early Diagnosis and Treatment of Acoustic Nerve Tumors. J. Lawrence Pool and Arthur A. Pava. Thomas, Springfield, Ill., 1957. 169 pp. $5.50.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Conference on the Role of Gravitation in Physics. At the University of North Carolina, Chapel Hill, 18–23 January 1957. WADC Tech. Rept. 57–216. ASTIA Document No. AD 118180. Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, 1957 (order from ASTIA Document Service Center, Knott Building, Dayton 2, Ohio). 155 pp.

Papers on Reduction Methods for Photographic Meteors. Smithsonian Contributions to Astrophysics, vol. 1, No. 2. 61 pp. *Chromospheric Spicules.* Sarah L. Lippincott. *Studies of Solar Granulation.* Gerard Wlérick. *Variations in the Thermodynamic State of the Chromosphere over the Sunspot Cycle.* R. G. Athay, D. H. Menzel, F. Q. Orrall. Smithsonian Contributions to Astrophysics, vol. 2, Nos. 2–4. 36 pp. Smithsonian Institution, Washington, 1957.

Blueprints in 3-D and Drawing in Motion. David Gordon. The Author, 771 Lindley St., Bridgeport, Conn. 2 pp.

The Culicine Mosquitoes of the Indomalayan Area. pt. 1, *Genus Ficalbia Theobald.* P. F. Mattingly. 61 pp. 15s. *New Genera and Species of Ethiopian, Mascarene and Australian Reduviidae (Hemiptera-Heteroptera) in the British Museum (N.H.), London.* Bulletin, Entomology, vol. 5, No. 2. 53 pp. 5s. *The Sessile Tunicata.* John Murray Expedition 1933–34, Scientific Repts., vol. X, No. 4. Patricia Kott. 21 pp. 8s. British Museum (Natural History), London, 1957.

Meetings and Societies

Biomedical Instrumentation

Almost 125 scientists and engineers from 60 different universities and industrial institutions gathered at the New England Institute for Medical Research in Ridgefield, Conn., for a 2-day symposium on 10–11 June. The symposium was entitled "A Conceptual Clinic for New Instrumentation for Biology and Medicine" and was designed to present to physical scientists and engineers some basic biomedical problems for which there is no instrumentation or for which the existing instrumentation is inadequate. The relative difficulty of communication between the biomedical and the physicoengineering fields has resulted in a considerable number of gaps, which can be filled. This symposium was an attempt to help remedy the deficiency in communication. Virtually all the biomedical problems which were discussed were presented in physical and engineering terms.

Among the speakers were Daniel Boroff, Christopher Coates, Richard Day, John Fitzgerald, Lewis Fox, Irving Friedman, Harold Genvert, John Heller, J. Miles O'Brien, Norbert Wiener, and Richard Zucker. The problems presented were far-ranging. An attempt was made to present three aspects of problems in instrumentation: those concerned with (i) instruments to be used by the practitioner, (ii) instruments to be used in the analytical laboratory, and (iii) instruments for use in the research laboratory.

Wiener discussed the instrumentation that he is currently using, as well as that proposed for further use, for analyzing fine structure in alpha rhythm from electroencephalograms. He indicated that the astonishing regularity of the periodicity of peaks in the fine structure could be a useful tool for further physiologic investigation of brain mechanisms and drugs.

Day explored the physical parameters in a developing and mature subdural hematoma and discussed instrumentation for precise localization. He also discussed the probable correlation between illness in premature infants and the rate of fingernail growth. He suggested the need for instrumentation which would make it possible to measure the rate of fingernail growth within a relatively few minutes. Fitzgerald suggested the greater need for knowledge about molecules in health and disease. He suggested that a variety of physical principles might be used in order to substitute physical methods for chemical methods of analysis in a variety of body fluids. Such techniques could result in a quantum jump in the speed, delicacy, accuracy, and range of possible chemical determinations.

Fox requested instrumentation which might accurately measure the degree and direction of the impact of one tooth on another, because of the probable interrelationship between malocclusion and periodontal disease. Friedman requested a method which would obviate the use of x-ray in the determination of pelvimetry in order that both the fetus and the ovaries of the pregnant woman might be spared from radiation in so far as is possible.

Genvert explored some of the areas in surgery where instrumentation that is more than a half-century old might be replaced with more modern and effective instrumentation. Heller explored a variety of physical parameters which might be used in developing instruments to measure various determinants in physical diagnoses, such as differential density, swelling, tumors, cavitation, and cyst formation.

O'Brien suggested the design of a device which would effectively induce transient force fields in nonmagnetic foreign bodies in the eye so that these could be removed in a manner similar to the magnetic removal of ferrous foreign bodies. He also explored the use of a moderate-voltage, high-amperage, linear accelerator for ophthalmic tumors. Coates demonstrated some of the bioelectric parameters manifested by electric eels, including their ability to locate foreign bodies under water by what appear to be electrical means.

The session culminated with a variety of suggestions about ways to increase the interchange of physical and engineering knowledge with individuals in the biomedical field in order to capitalize further on this knowledge in designing new instrumentation.

This symposium was cosponsored by the New England Institute for Medical Research and the Foundation for Instrumentation Education and Research.

JOHN H. HELLER
New England Institute for Medical Research, Ridgefield, Connecticut

Society Elections

■ Genetics Society of Canada: pres., T. J. Arnason, University of Saskatchewan, Saskatoon, Sask.; v. pres., C. J. Bishop, Experimental Farm, Kentville, N.S.; sec.-treas., A. Wilkes, Science Service Building, Carling Ave., Ottawa, Ont., Canada.

■ Society of Nuclear Medicine: pres., Marshall Brucer, Oak Ridge, Tenn.; pres. elect, Henry L. Jaffee, Los Angeles, Calif.; v. pres., Franz Bauer, Los Angeles, Calif.; v. pres. elect, Dwight E. Clark, Chicago, Ill.; sec., Robert W. Lackey, 452 Metropolitan Building, Denver 2, Colo.; treas., Lindon Seed, Chicago, Ill.

■ American Society of Ichthyologists: pres., Edward H. Taylor, University of Kansas; v. pres. for finance, John C. Marr, California State Fisheries Laboratory; v. pres. for conservation, Boyd Walker, University of California at Los Angeles; v. pres. for membership, James Kezer, Oregon State College; sec., Roger Conant, Philadelphia Zoological Society; treas., James Bohlke, Philadelphia Academy of Science; publications sec., N. Bayard Green, Marshall College.

■ Cook Inlet Branch, AAAS Alaska Division: Roger R. Robinson, Bureau of Land Management; v. pres., H. P. Gazaway, Alaska Agricultural Experiment Station; sec.-treas., Clarissa Allen, Arctic Health Research Center.

Forthcoming Events

August

25–27. Pacific Division-AAAS, annual, in conjunction with American Inst. of Biological Sciences, Stanford, Calif. (R. C. Miller, California Academy of Sciences, Golden Gate Park, San Francisco, Calif.)

25–28. American Farm Economic Assoc., natl., Asheville, N.C. (L. S. Hardin, Dept. of Agricultural Economics, Purdue Univ., Lafayette, Ind.)

25–29. American Institute of Biological Sciences, annual, Stanford, Calif. (H. T. Cox, AIBS, 2000 P St., NW, Washington 6.)

26–28. Gas Dynamics Symp., 2nd, Evanston, Ill. (A. B. Cambel, Technological Inst., Northwestern Univ., Evanston.)

26–29. Boundary Layer Research, internatl. symp., Freiburg, Breisgau, Germany. (H. Görtler, Mathematisches In-

stitut der Universität, Hebelstrasse 40 Freiburg, Breisgau.)

26–29. Mathematical Assoc. of America, 38th summer, University Park, Pa. (H. M. Gehman, Univ. of Buffalo, Buffalo 14, N.Y.)

26–30. American Mathematical Soc. 62nd summer, University Park, Pa. (J. H. Curtiss, AMS, 190 Hope St., Providence 6, R.I.)

26–30. Infrared Spectroscopy Inst., 8th annual, Nashville, Tenn. (N. Fuson, Infrared Spectroscopy Inst., Fisk Univ., Nashville 8.)

26–31. Low Temperature Physics and Chemistry, 5th internatl. conf., Madison, Wis. (J. R. Dillinger, Dept. of Physics, Univ. of Wisconsin, Madison 6.)

27. Society for Industrial and Applied Mathematics, summer, University Park, Pa. (D. L. Thomsen, Jr., 807 Enquirer Bldg., Cincinnati 2, Ohio.)

27–29. American Sociological Soc., annual, Washington, D.C. (Mrs. M. W. Riley, ASS, New York Univ., Washington Sq., New York 3.)

27–30. Biological Photographic Assoc., 27th annual, Rochester, Minn. (S. J. McComb, Section of Photography, Mayo Clinic, Rochester.)

28–30. American Inst. of Electrical Engineers, Pacific general, Pasco, Wash. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

28–30. American Inst. of Electrical Ensymp., East Lansing, Mich. (H. J. Noebels, IGC Symp., Instrument Soc. of America, 313 Sixth Ave., Pittsburgh, Pa.)

28–31. Soil Conservation Soc. of America, annual, Asilomar, Calif. (H. W. Pritchard, 838 Fifth Ave., Des Moines 14, Iowa.)

28–3. Cell Biology, 9th internatl. cong., St. Andrews, Scotland. (H. G. Callan, Dept. of National History, Bell Pettigrew Museum, The University, St. Andrews.)

29–30. Computers and Data Processing, 4th annual symp., Denver, Colo. (J. M. Cavenah, Denver Research Inst., Univ. of Denver, Denver 10.)

29–30. Econometric Soc., European meeting, Luxemburg, Duchy of Luxemburg. (Econometric Soc., Box 1264, Yale Station, New Haven, Conn.)

29–31. Group Psychotherapy, 2nd internatl. cong., Zurich, Switzerland. (S. Lebovici, 3, Avenue President Wilson, Paris 16e, France.)

29–2. European Orthodontic Soc., annual, Geneva, Switzerland. (E. Fernex, 1, Place du Port, Geneva.)

29–3. International Geographical Cong., Tokyo, Japan. (W. W. Atwood, Jr., National Acad. of Sciences, 2101 Constitution Ave., Washington 25.)

30–5. American Psychological Assoc., annual, New York, N.Y. (R. W. Russell, APA, 1333 16 St., NW, Washington 6.)

31–2. Astronomical League, annual, Kansas City, Mo. (Mrs. W. A. Cherup, 4 Klopfer, Pittsburgh 9, Pa.)

31–3, Psychometric Soc., annual, New York, N.Y. (P. DuBois, Dept. of Psychology, Washington Univ., St. Louis, Mo.)

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September

1–6. Laurentian Hormone Conf., AAAS, Mont Tremblant, Quebec, Canada. (G. Pincus, LHC, 222 Maple Ave., Shrewsbury, Mass.)

1–7. Psychiatry, 2nd world cong., Zurich, Switzerland. (J. Wyrsch, Tottikon, Stans, Nidwald, Switzerland.)

1–16. Aeronautical Conf., 6th internatl., London and Folkestone, Kent, England. (S. P. Johnston, Inst. of Aeronautical Sciences, 2 E. 64 St., New York 21.)

2–5. American Physiological Soc., Iowa City, Iowa. (M. O. Lee, 9650 Wisconsin Ave., Washington 14.)

2–5. Passivity, internatl. symp., Darmstadt, Germany. (German Bunsen Gesellschaft, Postfach 11, Duisburg, Germany.)

2–6. Operational Research, internatl. conf., Oxford, England. (T. Page, 7100 Connecticut Ave., Chevy Chase, Md.)

2–16. Carbon-14 Dating, 3rd internatl. conf., in conjunction with INQUA, Madrid-Barcelona, Spain. (M. Rubin, U.S. Geological Survey, Washington 25.)

2–16. International Assoc. on Quarternary Research, 5th internatl. cong., Madrid-Barcelona, Spain. (M. L. Solé Sabarís, Instituto Geológico, Universidad, Barcelona.)

3–4. Meteoritical Soc., 20th annual, Los Angeles, Calif. (J. A. Russell, 3518 University Ave., Los Angeles 7.)

3–6. Calorimetry Conf., 12th, Wentworth-by-the-Sea, N.H. (H. A. Boorse, Pupin Physics Lab., Columbia Univ., New York, N.Y.)

3–6. Matrix Computations Conf., Detroit, Mich. (W. Givens, Dept. of Mathematics, Wayne State Univ., Detroit 2, Mich.)

3–14. International Union of Geodesy and Geophysics, 11th general assembly, Toronto, Ont., Canada. (J. A. Jacobs, 49 St. George St., Toronto.)

4–5. Society of General Physiologists, annual, Woods Hole, Mass. (A. M. Shanes, National Institutes of Health, Bethesda 14, Md.)

(See issue of 19 July for comprehensive list)

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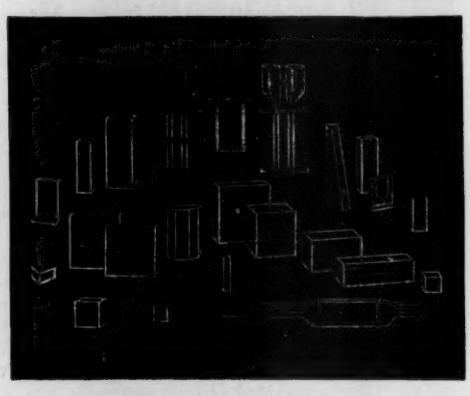

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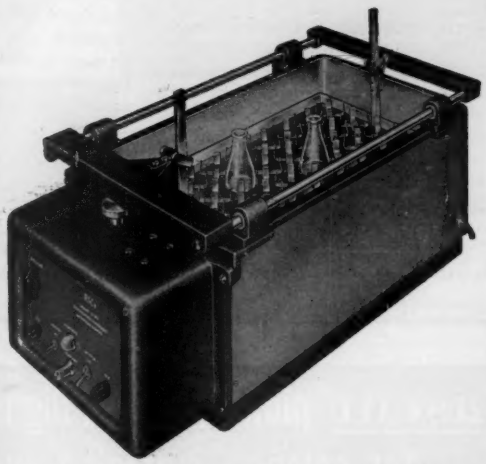

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EQUIPMENT NEWS

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■ SAND AND DUST CHAMBER provides a controlled composition and density level and sand and dust for testing. Relative humidity is automatically maintained below 30 percent. Temperature is maintained constant at either 25° or 70°C. (Tenney Engineering Inc., Dept. S430)

■ X-RAY VIEWER increases readability of x-ray pictures through contrast enhancement and color TV techniques. Areas of equal optical contrast are displayed in the same color, while variations in density are distinguished by variations in color. The range of the photograph to be viewed is converted to a sequence of electric signals by a cathode-ray, flying-spot scanner. The signal is amplified and subjected to electronic contrast enhancement. The amplified signal is next fed through a color monitor where the picture is reproduced in color. The image can also be converted from negative to positive by electronic means. (Philco Corp., Dept. S439)

■ SPHYGMOGRAPH SYSTEM uses a condenser microphone to detect pulse waves and sounds and records them on an electrocardiograph recorder. Simultaneously recorded are occluding cuff pressures, which are converted into electric signals by a mercury manometer that contains accurately placed platinum electrodes. (Medical Electronics Development Co., Dept. S455)

■ HIGH-TEMPERATURE ACCELEROMETER provides an output of 8 mv/grav in ambient temperatures up to 500°F. The associated cathode follower and Teflon-insulated, noise-treated cable can also be used in 500°F ambient temperature; this permits them to be placed near the accelerometer. Acceleration range is 0.25 to 1000 grav. (Endevco Corporation, Dept. S465)

■ SEISMOGRAPH, manufactured by Hilger and Watts, Ltd., is of portable design. The instrument records for 24 hr at 60 mm/min. The seismometer elements are of the moving coil type with permanent magnetic field. The natural period is 1 sec in both vertical and horizontal positions. The unit is sealed in a metal case to permit burying in open ground. Ground movements on the order of 10^{-7} cm can be detected. The recorder, of the photographic drum type, can accommodate three seismometers. (Jarrell-Ash Co., Dept. S456)

■ LEAK DETECTOR is a halogen-sensitive instrument that will detect a vacuum system leak of 2 in.^{3}/year. The system to be inspected is connected to the instrument and evacuated to a pressure of 80 to 200 μ. The outside is then blanketed with Freon-12 as a tracer gas. This is followed by probing with a fine gas-stream probe to pinpoint an indicated leak. (NRC Equipment Corp., Dept. S438)

■ SELF-BALANCING POTENTIOMETRIC RECORDER measures current or voltage in 40 ranges. Nine chart speeds, from ⅓ to 12 in./min, are standard, with provision for optional 1-to-5 multiplication or 10-to-1 reduction. Eleven ranges from 1.25 to 1250 are selectably direct reading in millivolts, milliamperes, or microamperes. Higher voltage ranges are provided through a divider. Accuracy is ± 0.1 percent or ± 20 μv, whichever is greater, and speed is 1.8 sec full scale on standard instruments. Chart width is 250 mm. Chart motion at 20 ft/min is provided for scanning in either direction. (E. H. Sargent and Co., Dept. S459)

■ INTRAHEART MICROPHONE, designed to be passed through an artery or vein into any part of the heart, measures 0.05 in. in diameter by 0.75 in. long. The microphone is inserted into the tip of a standard cardiac catheter and connects by cable to an oscilloscope. Blood pressure is also measured by a diaphragm in the catheter tip and is displayed simultaneously. (Gulton Industries Inc., Dept. S453)

■ CONTACT MICRORADIOGRAPHY INSTRUMENT forms an image by bringing the specimen into close contact with a photographic plate. The photographic x-ray image is in turn magnified and photographed with a light microscope. Useful magnification of 500 is obtainable. Very soft x-radiation is obtained from a tube provided with an extremely thin beryllium radiation window and operating at 5 kv or lower. (Philips Electronics Inc., Dept. S461)

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■ COIL TURN COUNTER measures the number of turns on coils wound on nonmagnetic forms. Models are available for ranges up to 0 to 61,000 turns. Accuracy is said to be better than ±0.1 percent. The instrument reads directly in number of turns. (Sunshine Scientific Instrument Co., Dept. S508)

■ BIOLOGICAL STAINS and related products are described in a 52-page catalog supplement. Stains in crystalline and in solution form are listed, as well as histological and histochemical reagents. (Hartman-Leddon Co., Dept. S486)

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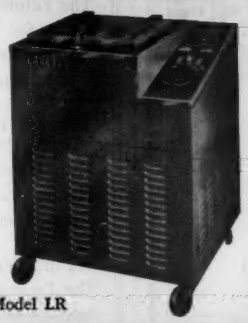

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1. W. J. Johnson and J. D. McColl, Science *122*: 834, 1955
2. W. J. Johnson and J. D. McColl, Fed. Proc. *15*: 284, 1956
3. D. M. Shapiro and M. M. Kligerman, Proc. No. Am. Radiol. Soc. 1956
4. S. L. Halliday, *et al*, Fed. Proc. *16*: 190, 1957
5. J. D. McColl, W. B. Rice and V. M. Adamkiewicz, Can. J. Biochem. & Physiol., In Press, 1957

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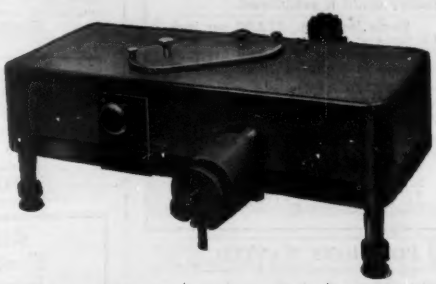

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124th AAAS MEETING

Indianapolis, December 26-30, 1957

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As in any city, single-bedded rooms may become scarce; double rooms for single occupancy cost more; for a lower rate, share a twin-bedded room with a colleague. Most hotels will place comfortable rollaway beds in rooms or suites at 2.50 to 3.00 per night. Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, and also probable date of departure.

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Date of Application .....

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(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)

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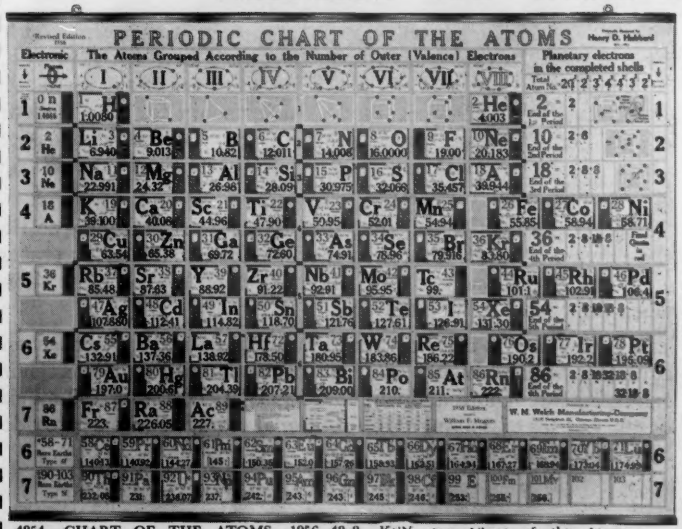

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- Electronegativeness
- Electropositiveness
- Elementary Particles
- End-Atom Cubic Structure
- End-Atom Number Formula
- Expansivity
- Group (Column or Family)
- Ionization Potential
- Isotopes
- Lowest Spectral Term of Normal State
- Mass-Energy Equivalent
- Melting Point
- Nuclear Composition
- Paramagnetism
- Periods (Rows)
- Planets
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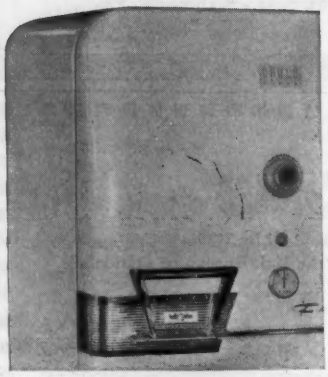

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